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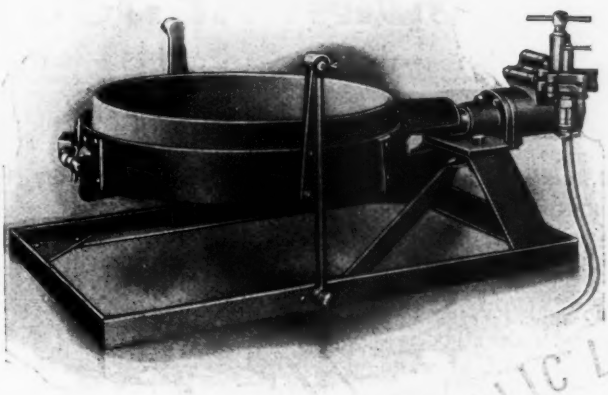

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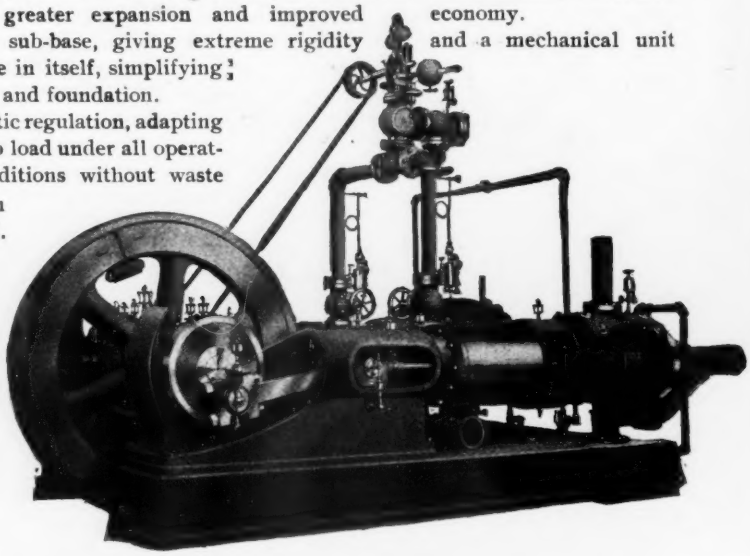

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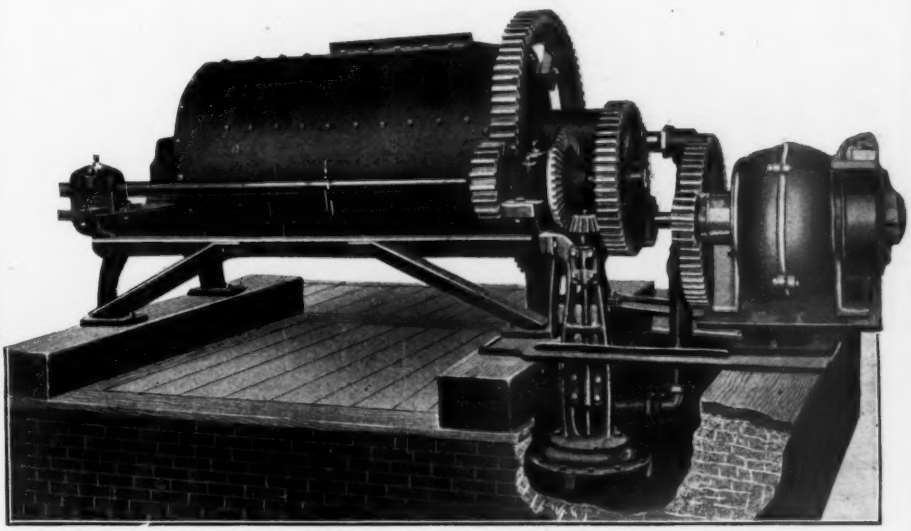

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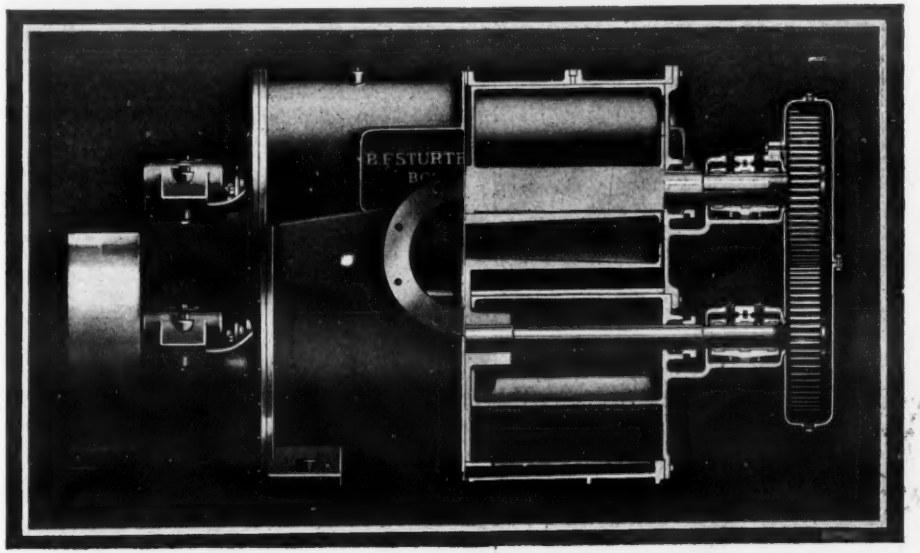

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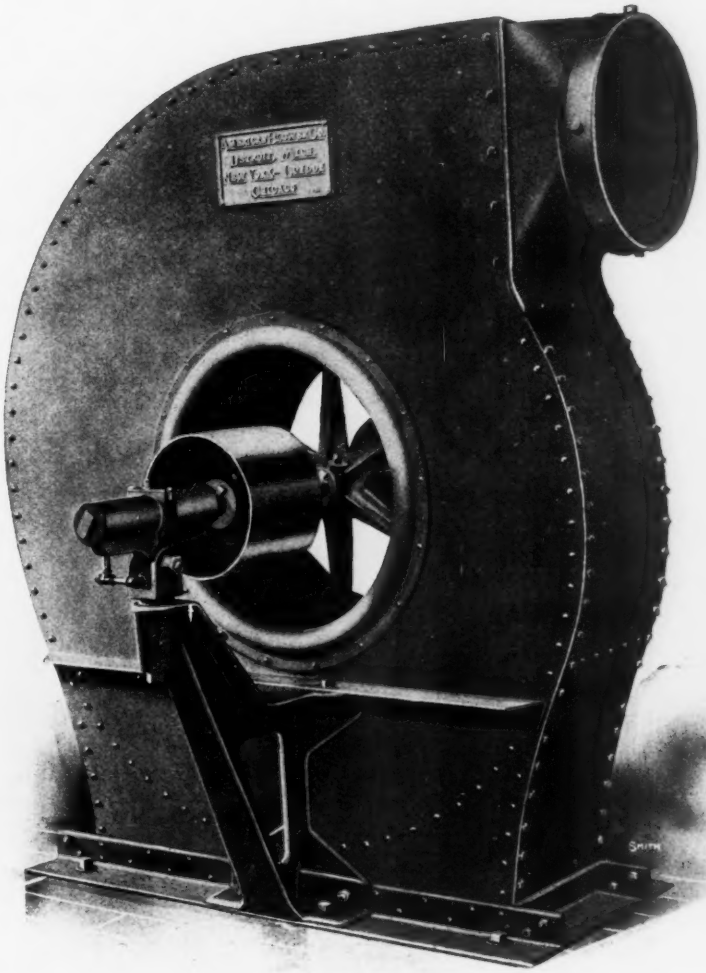

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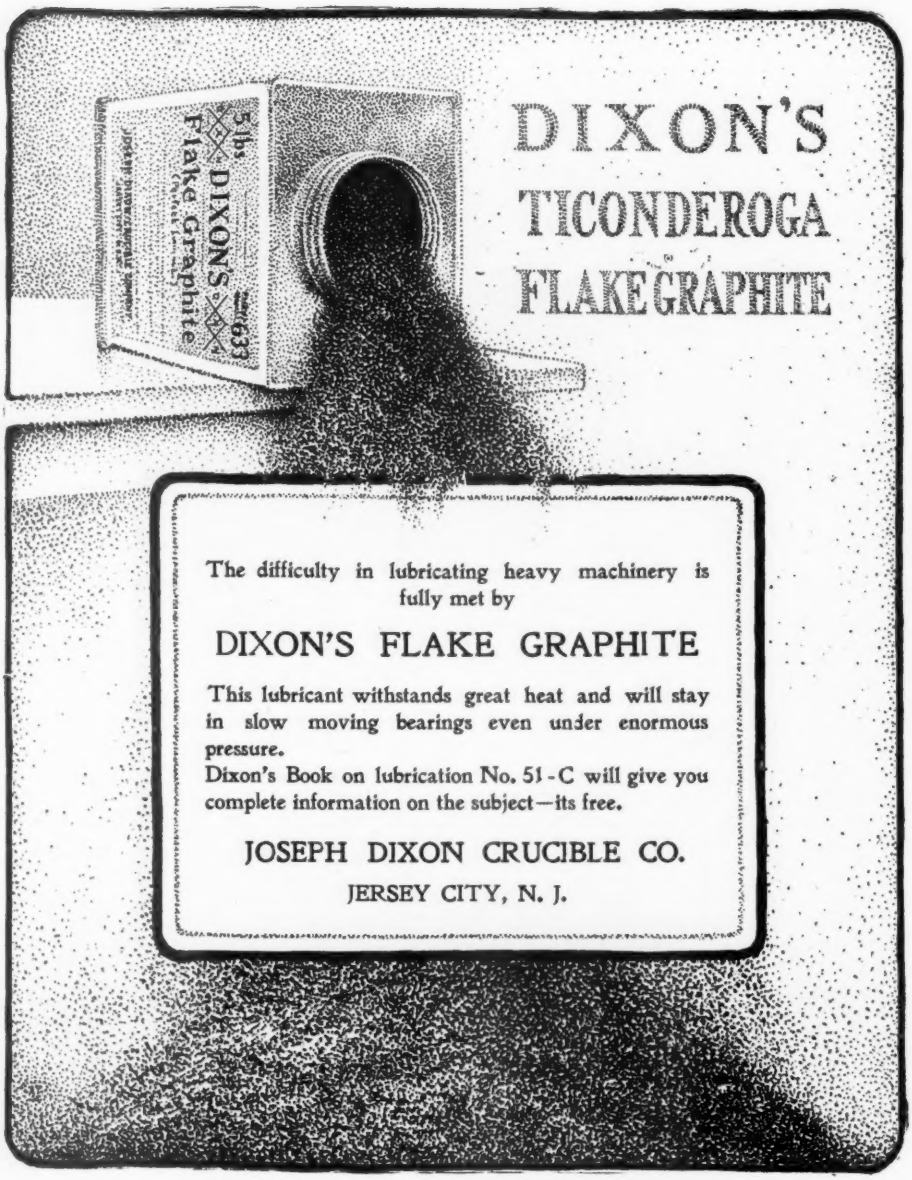
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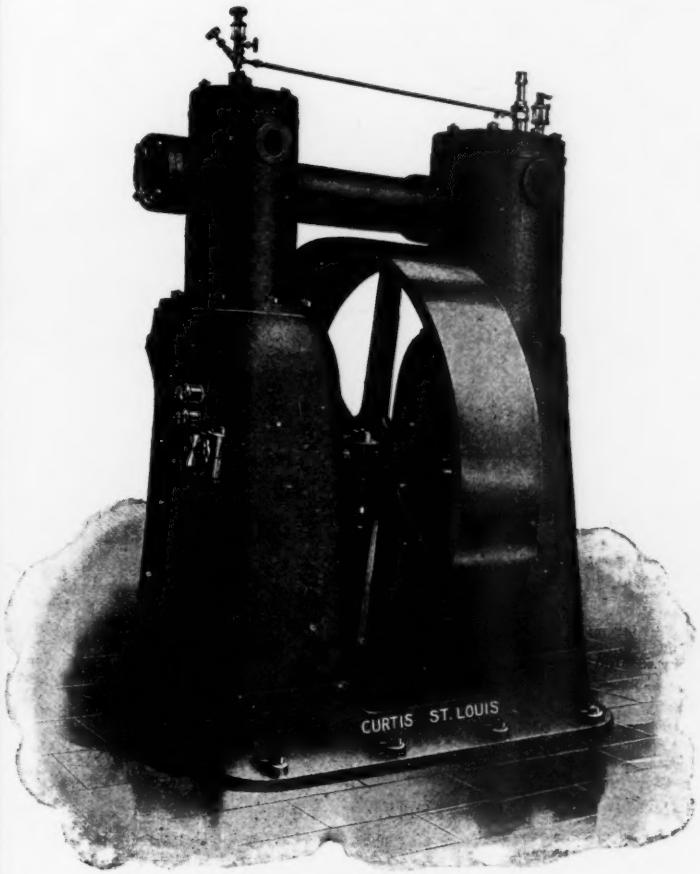

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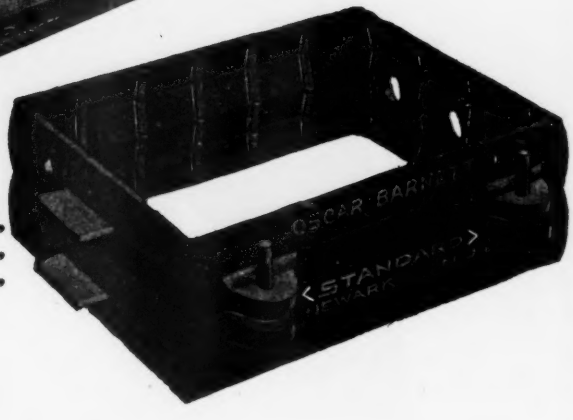

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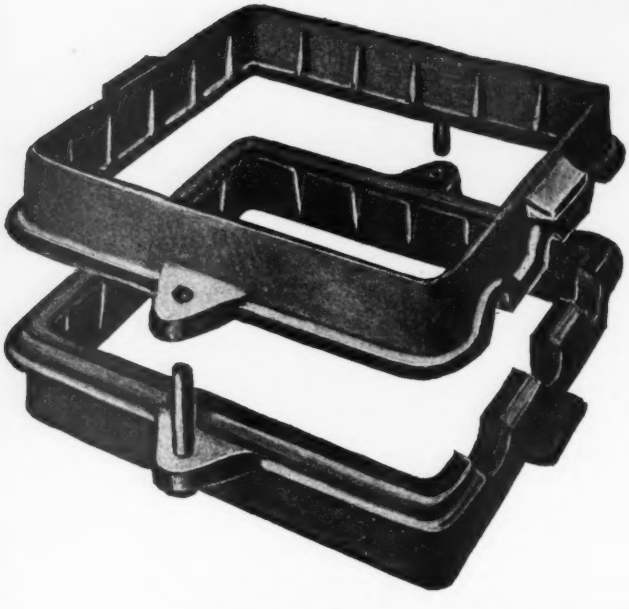

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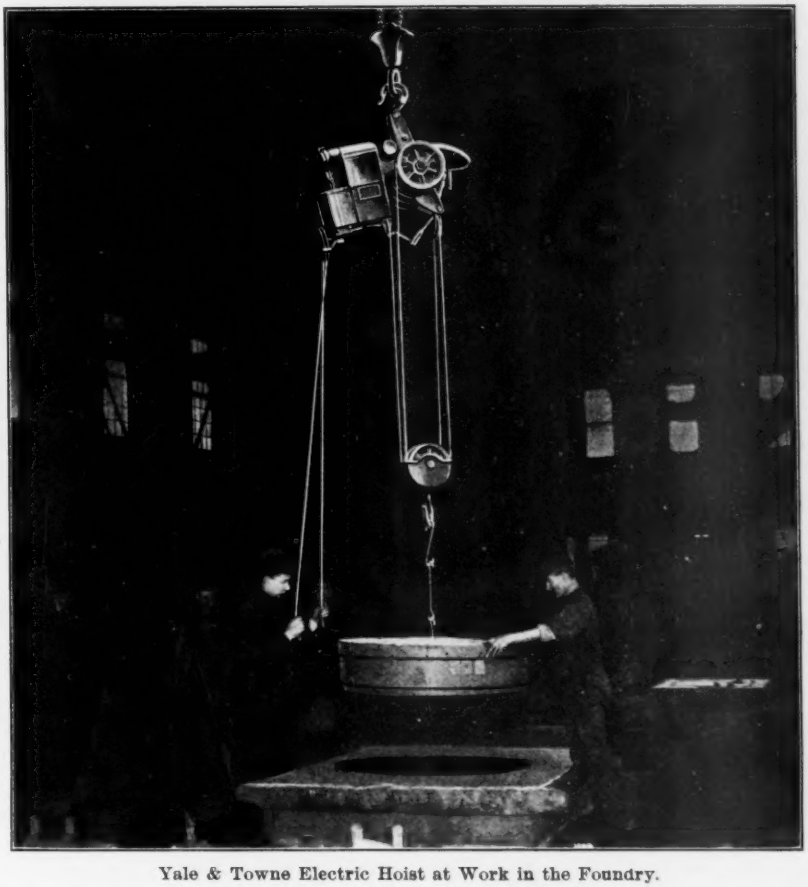

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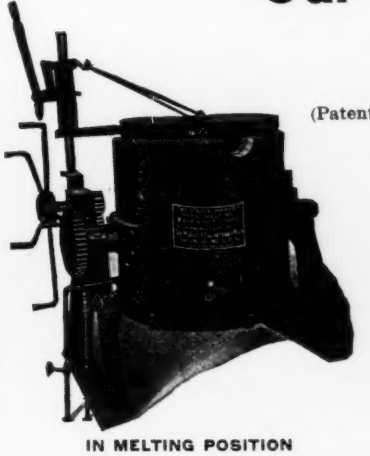

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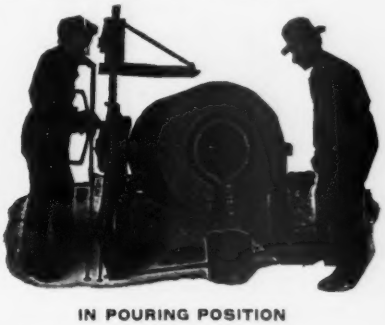
(Patented in the United States and all foreign countries.)



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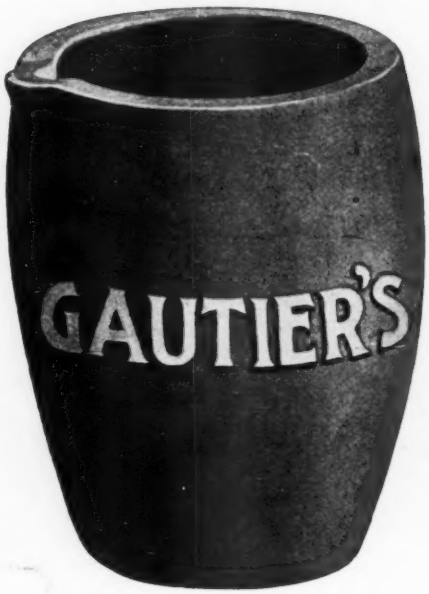

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THE FOUNDRY

Vol. 29, No. 1. *CLEVELAND, OHIO, SEPTEMBER, 1906.* *Whole No. 169*

British Foundrymen's Association

Annual Convention at Middlesbrough.

The third annual convention of the British Foundrymen's Association was held in the lecture hall of the Middlesbrough high school, Albert road, Middlesbrough, on Tuesday, Wednesday and Thursday, August 7, 8 and 9. There was a large attendance of members, Mr. Robert Buchanan, Walsall, last year's president occupying the chair at the earlier stage of the proceedings. There were also present: Messrs. P. Munnoch, Middlesbrough; J. Ellis, Southampton; J. Oswald, London; T. W. Markham, Bolton; T. McFarlane, Horshay; J. Shaw, Dudley; R. Mason, Birmingham; L. Cannell, Newark; A. Bowman, Crough; G. M. Fletcher, King's Lynn; H. Trandridge, Bury; W. Hughes, Bishop's Stortford; J. B. Tattersall, Birmingham; W. R. Wilson, Liverpool; W. Vickers, Birmingham; G. M. Riches, Beecles; G. M. Mather, Ashford; W. Broughton, Gateshead; F. O. Robinson, Leicester; J. Chadwick, Bolton; J. Butler, Salford; Harry Winterton, Birmingham; P. Longmuir, Sheffield; W. Newlands, Stockton-on-Tees; Sidney A. Gibson, S. A. Russell and S. Russell, all of Leicester; J. W. Sloan, Leeds; C. B. Crump, Wolverhampton; R. Davies, St. Helens; J. Deardon, St. Helens; B. F. Sperrin, Portsmouth; E. Houghton, Chesterfield; E. Allbut, Chesterfield; H. Pilkington, Chesterfield; F. J. Cook, Birmingham, and Professor Turner, and F. W. Finch, secretary.

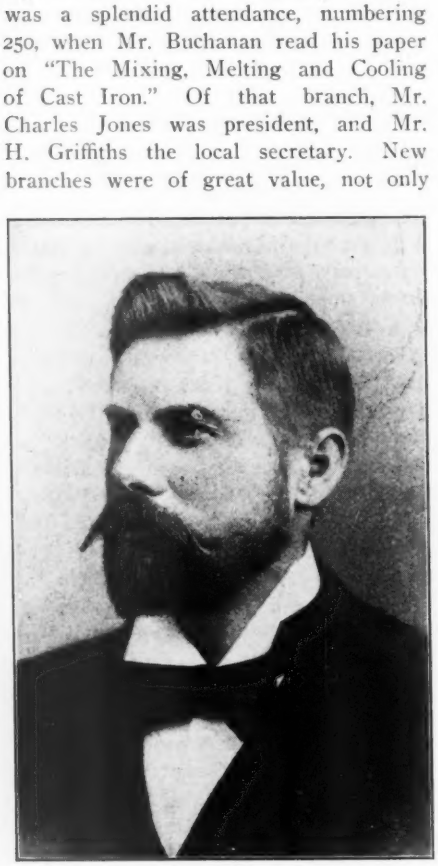
The chairman (Mr. Buchanan) said he had pleasure in welcoming the members and he hoped their visit would be a source of pleasure and satisfaction. He had great pleasure in announcing the presence of Prof. Turner of Birmingham, whose name was known not only in England but all over the world, as a distinguished meallurgist, especially in cast iron. No doubt he would be able to give them something of his abundant knowledge on those subjects.

The secretary announced apologies from Messrs. C. Jones, Cardiff; W. Cresswell, Birmingham; T. Westgarth, Middlesbrough, who was kept away by illness, and Mr. Roxburgh, of Kilmarnock. The last named gentleman regretted his absence and announced that he had entrusted the reading of his paper to the secretary, Mr. Finch.

The chairman said they all regretted Mr. Westgarth's absence, especially in view of the cause.

The secretary then read the annual report. He was pleased to inform them that since the convention at Glasgow last year the association had made steady progress and the membership had increased. The association was started in 1904, and in August of that year there was a membership of 89. Twelve months later it was 121, and the present membership was 180. They had enrolled 48 members since last convention. The finances were very satisfactory, as they had a balance in hand of £6.15.5½; 35 new members had joined since the beginning of the year and the total subscriptions received were £51.-15.5½. They had a balance in hand of £39.7.11½ for future requirements. Since the last convention they had been able to form three branches of the association, one at Manchester, where several meetings had been held and papers read and discussed. Mr. W. Russell, of Pendleton, was the president, and Mr. J. G. Smart the local secretary. They had held two or three meetings and papers had been read. They had formed

a district also in Birmingham, with Mr. R. Buchanan as president and Mr. F. J. Cook local secretary. The third branch was at Cardiff. At the inaugural meeting attended by Mr. Buchanan there was a splendid attendance, numbering 250, when Mr. Buchanan read his paper on "The Mixing, Melting and Cooling of Cast Iron." Of that branch, Mr. Charles Jones was president, and Mr. H. Griffiths the local secretary. New branches were of great value, not only



HERBERT PILKINGTON,
PRESIDENT OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

because they brought in new members, but because meetings could be held more frequently at a local branch. Arrangements had already been made for the holding of meetings and the reading of papers at all the branches. The president had lectured before the Leeds Engineering Society. Three meetings of the council had been held, and a ballot had been taken as to the meeting place of the convention, on which 98 voted. Of these 69 voted for Middlesbrough, 16 for Birmingham, and 13 for Sheffield. At the second meeting a circular was drawn up asking the employers to join the association, and as soon as possible that would be printed and sent out. It would be distinctly to the interest of the employers, for they would reap the benefit of all the work of the association. The invitations to the meeting had been sent out not only to members, but to foundries generally throughout this district. The president had been a tower of strength to the council and to himself as secretary, and he wished to return his thanks both to Mr. Buchanan and the council for the help rendered during the year. Mr. J. E. Stead had also proved very valuable as a friend to the association by obtaining permission to visit the works, and in this direction he had received valuable help from Mr. Munnoch and Mr. J. F. Goodwin, both members of the association. As secretary, he had done his best to further the interests of the association, but the work had been very heavy. For a long time he had given up every evening to the interests of the association which had practically taken up three parts of his spare time. The correspondence had been very heavy, and he thought the time had now arrived for them to choose another person as secretary of the association.

Mr. J. Ellis, Southampton, moved, and Mr. Newland, Stockton, seconded the adoption of the report. It was carried unanimously.

The chairman raised the question as to the duty of fixing future meeting places. The council had found it somewhat difficult to gauge the feelings of the members and in some degree to estimate the capabilities of the different places. Possibly they might prefer to decide at once where the next meeting should be held, or if they preferred they might leave it as before to the decision of the council with the understanding that the administrative body would consult the members.

Mr. H. Pilkington, Chesterfield, said that one great difficulty which must crop up shortly would be the time of meeting. They would soon have exhausted all the places at work during August bank holiday, and they ought to consider whether the time would not have to be altered. At the same time a very important consideration was that many members found the bank holiday the most convenient time.

Several members expressed themselves in favor of continuing the present method.

Mr. F. J. Cook, Birmingham, thought the present method had proved very successful and should be continued if possible; at the same time Birmingham would be impossible as a meeting place because very few firms started before Thursday. Any meeting there would be out of the question. At the same time as there were not more than one-third of the members present, it ought not to be decided immediately. The secretary pointed out that the cost of the present arrangement of settling the meeting was very trifling.

Mr. Cannell, Newark, suggested whether they might not some time meet on the continent, the suggestion apparently evoking some amusement.

Mr. Butler, Salford, moved a resolution in favor of postponing the settlement of the matter for the present.

The chairman suggested that after the discussion the only possible course was to postpone the matter in view of the complexity of the arrangements and the difficulty already existing arising from local arrangements. At his suggestion the meeting agreed to pass on to the next business.

The chairman said he had the greatest pleasure in proposing as his successor Mr. Herbert Pilkington. (Applause.) Personally he had had the honor to appear as president on two previous occasions, and his being first president was to him a source of the greatest possible pride and pleasure. It was true that the position was in some degree an onerous one, but he had been highly recompensed by their kindness and by the educative advantages he had been able to obtain. He should quit the presidential chair without any fear whatever for the association. Mr. Pilkington would prove himself to be an ideal president. As regards his qualifications, he was a past president of the South Staffordshire Iron and Steel Institute, a member of the Iron and Steel Institute, and of various other learned bodies, and he had written somewhat largely on subjects connected with cast iron. He would be ideal both as a business man and as one learned in the science of the subject. He had much pleasure in moving his election. (Applause.)

Mr. T. McFarlane, Horshay, seconded, and the proposition was adopted with acclamation.

Mr. Pilkington, Chesterfield, thanked the meeting very much for his election though he felt sure it would be a difficult task to emulate his predecessor. At the same time he would do everything he could for the benefit of the association. He felt certain it was calculated to do a large amount of good. He could count on the assistance of the members being extended to him as it had been to his predecessor. He thought they ought to propose a vote of thanks to Mr. Buchanan for his services as president. He knew from what he had seen that he had worked most strenuously to make it a success.

Mr. G. N. Fletcher, seconded, and Professor Turner supported, and the vote was unanimously approved.

Mr. Buchanan responding said he had some hesitation when he was asked to help to start the association, because he was very full of work in other directions. But he usually found it was the busy man who got the work to do. The man who had nothing to do could never find time to do anything. His two and a half years' presidency had brought him a great deal of pleasure as well as a great deal of work, and in future it would be to him a sweet recollection that he had been engaged in that good work. He had something more than personal interest in it, and he had little doubt that most of the members had joined not altogether from what they could get out of it or from what they could learn from it. Many of them he believed had to some extent a patriotic motive. They had recognized that their country, of which they were so proud, was not keeping up to the point of perfection it ought to attain. They believed that nothing should make them take a second place. He held that belief very strongly and as a citizen of his country he would never consent to Great Britain taking the second place

to any country in the world. It was with the ambition and hope that he could help on that good work in the foundry world and at least play their part like men that he put his hand to the plow. They fondly believed that that association was having a marked influence upon the foundry industry, and they meant to go on until they had elevated it to the attainment of all the knowledge and science which was available. One of their objects was to assure foundrymen that a great deal of information was at their command. On the scientific side this country, at least in the iron industry, was as highly developed as any country in the world, and it was also true that many of their foundries were second to none in the world; but there was a large substratum of foundries not what they ought to be and not what they could be. It was really to convince many of their fellow foundrymen that they did not know all there ought to be known, that they had worked together in that way. The association would go on with their good work of elevating the industry to a position at least of equality, and he was content to do his little best in the future, and eventually it would hold up its head proudly, fearing no competitors whatever. (Applause).

The president, Mr. Pilkington, moved the election of Mr. F. H. Cook, Birmingham, as vice president. Mr. Cook was a foundry manager connected with the great firm of Messrs. Bellis Morcom, of Birmingham. He was an enthusiast, willing to do his best for the trade. What was more important he was not afraid to tell them all that he had learned as the result of his experience. Some people, if they found any good thing that was new, they were too fond of keeping it to themselves. He would make a very able vice president.

Mr. B. F. Sperring, Portsmouth, seconded, declaring he could earnestly endorse every word that had been said.

The chairman putting the vote said he could cordially echo the compliments expressed. Mr. Cook would make an excellent vice president and in due time a president of the association. The resolution was carried with great heartiness.

Mr. Cook, Birmingham, thanked the meeting very heartily for the cordial manner of his election. At the same time he recognized the responsibility attaching to the office, but he should do all he could to further the interests of the association. (Applause.)

Mr. Buchanan, Birmingham, proposed the re-election of Mr. F. W. Finch, Gloucester, as secretary and treasurer. That appointment would be received with acclamation. Mr. Finch had done a great amount of work, and to him it had been a labor of love. The writing of forty or fifty letters a week was no small tax on his energies and they would find a difficulty in discovering a substitute, which, however, none of them desired to do.

Mr. J. Ellis, Southampton, in seconding, said they might call Mr. Finch the father of the association.

The chairman in putting the resolution said Mr. Finch was a hard worker, but he had a spirit of self-depreciation not quite justified. He was reminded of the lines by Burns:

"O wad some power the giftie gie us
"To see oursels as ithers see us,
"Twad fra mony a blunder frae us
"And foolish notion."

The resolution was carried with acclamation.

Mr. Finch, Gloucester, said while he thanked them for the heartiness of their election, he thought they would have been wiser to get some one else. (No.) It was true he had made it a labor of love, and many years ago felt the great necessity of such an association in England as well as in America. Ten or twelve years ago he set to work himself. He did not then know Mr. Buchanan or he should have taken him into his confidence. But the apathy of many foundry managers gave him the hump. However, the result of that labor had been the establishment of that magnificent association. But even now he sometimes got letters which set up his back, and he had to say to himself, "Finch, your feathers must close up." (Laughter.) Anyhow he would do his best this year to push the association as

he had done in the past. While he thanked them, he wished they had got somebody else.

At this stage the president expressed his great pleasure in introducing the mayor of Middlesbrough, Councillor T. Roddam Dent, who had a hearty reception.

The mayor said he was very glad to have privilege of welcoming the association in his official capacity as mayor on behalf of the people of Middlesbrough. They regarded them as practical men who had come there to deliberate. It was by such as them and kindred associations that information was disseminated which was not only good for them, but for this district and for the whole community. He hoped they would go away having seen something of Middlesbrough which might be to their advantage and he hoped they might leave some information and some hints which might be useful to them. They had a selfish interest as well as a desire to be social and pleasant. He hoped sincerely that they would avail themselves of anything with which they came in contact, and that Middlesbrough might see them again in years to come. Associations of that description disseminated knowledge which would be to the advantage of others, and he hoped they all felt they were gathering information which would enable them to be of use not only to the world now living but to those who would follow. Although they did not see many actual beauty spots in Middlesbrough, a very beautiful district surrounded them, and if they had too much sunshine they would not have so much to keep the community contented. They had a fairly prosperous district as the result of the resources around them, and their success was largely due to the labor of practical men like themselves to whom they had much reason to be thankful. He hoped their recollections of Middlesbrough would be pleasant. No doubt Birmingham knew a little better about certain things than did Middlesbrough, but at the same time he had no doubt they would find things to interest them here, and be able to gain some little information from their experience. On the other hand, if they left something behind, Middlesbrough would be very much obliged to them. (Applause.)

The president acknowledged the heartiness of the welcome. It was true there were not many beauty spots in the immediate neighborhood, but he remembered they had a charming park. At the same time, the town appealed to everyone in the iron and engineering trade. It was one of the most progressive towns in the country, and its progress and prosperity had been phenomenal. They were greatly obliged to the mayor for finding time from his numerous duties to come and see them.

The president proposed the election of the council as follows: Messrs. R. Buchanan, Birmingham; P. Longmuir, Sheffield; J. G. Stewart; C. Jones, Cardiff; W. Vickers, Birmingham; W. Roxburgh, Kilmarnock; J. Moorhead, Birmingham; J. Ellis, Southampton; T. McFarlane, Horshay; R. Mason, Birmingham, and W. F. Bagnall.

Mr. G. N. Fletcher, King's Lynn, seconded, and the resolution was carried.

On the proposition of the president, seconded by Mr. Buchanan, it was agreed to adopt the rules of the association already circulated.

At this stage the mayor of Middlesbrough withdrew, the members showing their hearty appreciation of his visit by vociferous applause.

Mr. H. Winterton proposed a resolution thanking the officials of the association as a body for their services. Referring specially to Mr. Finch, he said he had just come back from America and he thought their secretary had very much of the go-ahead style so characteristic of the American Foundrymen's Association. Every member of the American body regarded himself as an envoy whose duty it was to obtain fresh members.

Mr. Cannell, Newark, seconded. The resolution was carried.

Mr. Finch responding, said he appreciated the comparison with America, and he was bound to say that the association would not have reached its present stage without a good deal of pushing. At the

same time a hearty co-operation of the members was of the greatest importance.

Presidential Address.

The president then proceeded to give his address. He regarded such associations as powerful factors for educational work and dwelt on the good it could do. He then gave a very interesting review of some points of interest in the production and use of foundry iron. The address will be printed in the October number of THE FOUNDRY.

Mr. Mather, Ashford, referring to what had been said about the iron deposits of Kent by the president said they say very little in the neighborhood of London of the foundry industry. But it was still true that there had been a great casting industry as far back as the year 1500, in which year cannon were made for the French government. He had in his possession some old fire-backs dated 1649 which were cast somewhere in mid-Kent. He had pleasure in moving a vote of thanks to the president.

Professor Turner, Birmingham, seconding, said they were all very much indebted for that address. They did not propose to discuss it, and they did not say they agreed with everything that had been said. (Laughter.) At all events Mr. Pilkington had given them matter for consideration.

The resolution was heartily carried.

The president responding said if they were pleased he was amply repaid. He had a suspicion at the breakfast table at the hotel that morning that Professor Turner thought something would be said which he would like to criticise very much. But he believed it was a rule in most societies that the president's address was not discussed, though he would no doubt get plenty of personal criticism from Professor Turner himself.

Mr. P. Munnoch, Middlesbrough, read his paper on "Grading Pig Iron for the Foundry," after which there was a discussion.

The president said that the paper displayed a great deal of ability, and speaking for himself as one who had had a great deal to do with pig iron, it seemed to him to display a greater appreciation of the situation than he had yet seen.

Professor Turner remarked that there was a good deal in the paper which they could not fully discuss. But he joined with the president in the remark that it showed a great amount of practical knowledge of the situation.

No doubt the ideal was that the founder should know completely the chemical composition and the mechanical properties of his metal such as its transverse strength and its shrinkage so as to know the grade of the metal. But in practice they could not carry out those ideals because of the question of time and expense. But the writer was endeavoring to give them that which he thought might personally be obtained from the iron producer, the composition of silicon and the grade which he took out as an indication of the amount of sulphur. And as far as he could make out he gave them what he regarded as a normal composition having a corresponding grade. But if they took an equivalent iron having a normal composition corresponding to each grade that composition was not the same as they might have expected. Hematite was distinctly different from ordinary iron, and from American iron which was particularly low in sulphur. If they knew the source of their iron they ought to know the percentage of phosphorus and the amount of manganese. But the author of the paper did not refer to those elements except incidentally. If they had Cleveland iron they knew approximately within a very small limit what the phosphorus and the manganese would be. But those familiar with the running of furnaces knew very well that iron varied in a very remarkable manner. In Cleveland iron the phosphorus was high and practically constant, but in South Staffordshire the difference was considerable. In the grading of iron the most important point that determined the grading was the size of the graphite and the conditions under which it had been separated. The graphite was the first thing to consider. They saw it separate on the top of the ladle

while the metal was perfectly fluid. And when the metal went on cooling the first thing to consider was the graphite. The temperatures would vary and it would separate at 90 degrees Cent. But if the heat was 730 Cent., the temperature being lower it would separate in smaller size and consequently the grain would be closer. If they knew the size of the graphite they knew the grade of the iron. That was what caused it to separate at various sizes. There were two elements to be considered, silicon in the first place which caused it to separate at all. Having silicon they had combined carbon in the graphite and the next element was sulphur. Every addition of sulphur made graphite smaller. In other words, it closed the grain. The author referred to glazed pig as having lower sulphur, but his own experience was that that kind of pig was not smaller. He had analyzed a considerable number of those glazed pig irons, and he always found them rather high in sulphur, 0.14 or 0.15, and it was to that fact he attributed the fine grained graphite. Having sufficient silicon gave a coarse grain usually. With sufficient sulphur present, they had a fine grain. He had been described as the apostle of silicon. (Laughter.) But too much silicon was a disadvantage; just as much a disadvantage as to have too little. The essential point in the foundry was to obtain the right proportion of silicon having regard to the properties they had in view. The great element to which the author had directed attention was sulphur, and he had done good service in that respect because the use of sulphur had not received the attention it deserved. He himself had said roughly that sulphur was twenty times as active in its effect as silicon. He had not the quantitative figures to prove that, but only his different observations of a considerable years; but his observation was that it required something like twenty parts of silicon in iron originally well balanced to neutralize the effect of one part of sulphur. And if they took as the author suggested, the proportion of sulphur as indicating the grade, they usually did not go far wrong. But, on the other hand, Mr. Parker, who gave us the proportion of combined carbon as indicating the grain, gave them a different test. It was from the size of the graphite associated with the others that gave them the indication of the grain. No doubt the important element which gave them the condition of the iron was the question of sulphur. No doubt also they should refer to the fact of the temperature at which the iron was made as having very considerable effect. They could see that in a very simple way, if they took some iron melted in the crucible at the lowest temperature, say 1,100 degrees, they would get a smaller proportion of carbon taken up and they would get a close grain, and so white iron would result. But if they had a higher temperature they would get a grayer iron, say up to 1,500 degrees Cent., they would get what was called No. 1, they would have no sulphur, but only carbon. So that by taking a carbon iron they would get a varying grade, and the higher the temperature in the blast furnace the coarser would be the grain produced. And that was how in cold blast iron they got the closer grain than in hot blast. He had no doubt they would find the paper of practical use.

Mr. Buchanan said he waited some time to get the author's definition of grading. It would have been better if the definition had come first. But the author used the term several times before he made them understand what he meant. The term was sufficiently wide to bear all sorts of interpretations. When he talked of No. 3 grade containing one per cent of silicon and No. 3 containing three per cent silicon he had great difficulty in presenting to his own mind what the iron would look like if one saw it. As regards the endeavor to fix a system of grading, the indefiniteness was charming. But to his own mind that was really shirking what was becoming to foundrymen an absolute necessity, and that was to fix a definite something by which he was going to judge what he was going to buy and what he was going to use. Personally, he did not see why they should look round for methods by

which to buy iron other than by analysis, so long as they had such a good object lesson in the case of the steelmakers. Why did the steelmakers not buy by grading? Did the steelmaker call his iron No. 1, 2, 3 or 4? He did not buy it in that way, but he bought by analysis. A rose by any other name than analysis would smell as sweet. What was sauce for the steel maker goose, was sauce for the iron founder gander. (Laughter.) The steel maker found that analysis paid him, and, in fact, it was the only possible way of carrying on business, and when the iron founder found that he would adopt analysis. When the steel maker found himself with a day's output of 200 or 250 tons of steel that was no good to anybody. They wanted a definnte something which would enable them to know what they were using and until he got that he should not be easy or happy. He was not going to accept names; they might call their iron No. 1, 2, 3 or 4, but that conveyed nothing to him. But if they gave him an analysis he knew what he was having, what he was going to use and what he was going to do with it. Selling by name only was of no value whatever. Blast furnace men must make up their minds that they would have to give the founders something more definite than numbers or grades, and personally he should not compromise in that respect. They could not produce definite results without a definite composition. They could do nothing if their carbon varied, but if he knew his composition he would be ready to swear to the result. The numbering of pig iron was the greatest obstacle to any kind of advance and might cover up serious differences in quality. Then they might alter the grade of iron by slow coooling. If the pig was run into a small pig bed in which time and space were important, and water was poured on to cool it, they might get a No. 3, but if the blast furnace man covered his pig with sand and let it cool properly he could sell his iron at 2s more a ton than the man who cooled quickly, though the only difference was in the relative percentage of graphite and combined carbon. Numbering as an indication of the constitution of iron was almost wholly deceptive, and cloaked the true condition or state of the metal. It was true that blast furnace people were not at all fond of giving analyses. But he thought it was rather giving the case away to say that the blast furnace man only analyzed his material and did not analyze his pig iron. The reason he stopped short at the stuff he produced was rather suggestive. Foundrymen must blame blast furnace men to some extent inasmuch as they traded too much on their innocence, but foundrymen were a little simpler than they ought to be credited with. It was no doubt a fact that the iron founder who analyzed iron got the best product, and he had a right to protest against having passed on to him iron unsuitable to his purpose. A blast furnace man had admitted to him that he had dumped upon him hematites with a high sulphur content rejected by a steel maker, and there was no system of grading which would protect the iron founder against that kind of treatment. He would have no dealings with anybody who sold simply by fracture, and he would give all his influence against that practice. Such practices were a hindrance to the foundry.

Mr. Longmuir, Sheffield, said that Mr. Buchanan had very well expressed his own feelings on the matter. Analysis was such a simple thing he could not understand why they should look for anything further, and it was not at all a costly thing. Grading by complete analysis was very easily done and they got definite information. With regard to the sulphur content, the American Foundrymen's Association gave their sulphur limit for No. 1 as 0.035, and of No. 2 as 0.045. That was very, very fine work, and he did not think that proportion of sulphur would injuriously affect the iron. Personally he thought if any change were made in grading it should be on a chemical basis, and the analysis was a system that could be easily followed.

Mr. Whitfield said he also agreed with Mr. Buchanan. Speaking as a steel

maker he could say his own class did not believe in grading by fracture, and when they did use that system they checked it by analysis, especially when they were making steel castings. With regard to the method of casting pig iron, he believed they would find that sand-beds would be less used and the casting machine more extensively adopted. But when pig iron was cooled by machine it got a chill and they could not grade that.

Mr. G. M. Riches, Beccles, said he would like to ask the author whether he thought chilled cast pig iron would give a similar structure to sand cast pig iron? He understood him to say that a high phosphorus iron had more silicon than a low phosphorus iron. Carron iron was supposed to be a low phosphorus grade and it was a dark gray.

Mr. Finch, Gloucester, said he was speaking to an iron founder in his district a short time ago and he asked how he could afford to pay a chemist to analyze his iron, and his answer was that there were five or six foundries in the district, and that there was no reason why they should not combine and pay a chemist to analyze their iron. He thought that suggestion was worth consideration, because it was an undoubted fact that small foundries could not afford the expense; but the matter could be very easily covered by combination and the result would very well pay for slight expense.

Mr. Fletcher, King's Lynn, said they would like to know what the expense was. If he had that knowledge he should be prepared to suggest analysis to his own employer.

Mr. Cannell, Newark, asked what would be the effect of manganese?

The president said the result of the discussion seemed to show what great sinners pig iron makers were. When the happy millennium came in which all the pig iron was bought by analysis, no doubt there would be the end of all foundry wasters; but it was an undoubted fact that those who made pig iron and used it themselves seemed to make quite as many wasters, and those who bought by analysis also made wasters. He could not see any practical difference depending upon that point. A comparison had been made between iron founders and steel makers. It was an undoubted fact that steel makers had to buy their iron by analysis, but it seemed to him that the making of steel and the making of castings were not at all compatible. In fact they were quite different matters altogether. It was cast iron when they had finished making their castings, and the physical circumstances seemed to him far more important than the chemical ones. Analysis of pig iron done with the greatest possible judgment and ability did not always represent in its result the pig iron they had. After all pig iron was a crude material and not a finished article, and if the day should arrive in which they would supply a definite material of which a definite casting was made—he was bound to say he did not think it would be early in coming—they had still the fact that unfortunately foundry pig iron seemed to be of such a nature that it might differ very much even on the same analysis. He did not think that selling by analysis would solve the problem of the iron founder. Casting by machine for the foundry had practically ceased. The iron founder would not have that iron. It was not a marketable product, and he had heard one or other say "You can't go on the market with it." Undoubtedly the machine was a very convenient way of disposing of the pig iron, better than the sand beds. (Laughter.) He entirely disagreed with the idea that when they had got analysis all their troubles would be over. Mr. Munnoch seemed to suggest that higher silicon might be due to a fast-driving furnace, but his own experience proved that a fast furnace produced a lower silicon on the same material. It was quite true that the newer furnace produced iron hotter than the smaller furnaces, but that was purely physical and had nothing to do with analysis at all. It was a factor, and the cupola melting the iron sufficiently hot would restore the chilled iron to its proper state. Referring to Professor Turner's remarks as to glazed iron, he had found two distinct classes

of glazed iron. The sulphur was high in the high class forge and low in the foundry. He had been struck by the classification of combined carbon and sulphur. He believed that sulphur did tell distinctly the grading of iron, and perhaps the combined carbon was an element of indication as to what the grading should be. Another circumstance bearing on the matter was one he was glad to see mentioned, and which he had not seen noticed to any extent before, and that was as to the total carbon in the pig iron. It was a very big factor that the total carbon varied very greatly in pig iron. He thought chemistry had not given sufficient attention to that point, and the carbon varied to a very great extent in conjunction with sulphur and governed the grain. That was precisely his experience and from that point of view he believed Mr. Munnoch had got nearer to the kernel of the matter than anything he had yet seen.

Mr. Munnoch replying to the discussion referring to Professor Turner's remarks, said he had found manganese and sulphur very tremendously in different classes of iron and even in the same iron. Practically in those used in Cleveland the phosphorus was always somewhere between 1.5 and 1.65 and manganese usually about 0.5 to 0.6. No. 3 was a gray either as forge or mottled, and it showed manganese going down to 0.25 or 0.3 in mottled Cleveland. There was a different amount of carbon in Cleveland hematite, but the difference did not alter the grade at all. The size of the grain and the appearance was independent of this carbon, and practically some of the carbon was displaced by the phosphorus and that affected the fracture. With regard to American iron being lower in sulphur, that was not his own experience. He had had a good deal of Alabama irons through his hands and they were quite as bad as British iron and varied as much. British irons as a rule, even in No. 3, did not contain sulphur beyond 0.009 to 0.15, which is practically forge iron. The low results of the American iron were probably due to the use of the evolution method which gave iron with a low manganese and with lower sulphur than the oxidation. With regard to glazed iron, which Mr. Pilkington mentioned, the glazing was due to the low carbon. An iron with a high carbon would take up more silicon before it glazed than an iron with a low carbon. With an ordinary Cleveland and a low carbon they could not go much above 4 per cent before the iron started to glaze. With hematite they could have 5 per cent before the glazed appearance would be seen. As to the definition of grading which Mr. Buchanan wanted, the grading was really the foundation of the price. Grading meant quality and as long as foundry men wanted a distinction they would keep on grading to a certain extent. The analysis of sulphur was equivalent to the grading, and they would have to pay a high price for a good composition for the same iron. (Laughter.) That was why foundry men did not believe in buying by analysis. They would have to pay a bigger price if they obtained a guarantee with the iron. As to the question of the appearance of fracture in iron that had 1 per cent of silicon or 3 per cent he had seen iron exactly similar in appearance, and it was impossible to distinguish the difference, although it had those different amounts of silicon. The iron would be exactly the same grade. That was due to the crystals being of the same size and therefore having the same appearance.

Mr. Buchanan: Does not that prove my point?

Mr. Munnoch: It proves that the silicon has no effect on the fracture.

Mr. Buchanan: And, therefore, it proves that grading is deceptive.

Mr. Munnoch: No, grading does not depend on silicon, and therefore it is not deceptive in that way.

Continuing, the speaker said, Mr. Buchanan wanted to know why they should not buy by analysis like the steel maker. The answer was that the requirements were altogether different. The foundry required something else besides pig iron. The steel maker required nothing but iron. But practically he bought iron with a certain propor-

tion of sulphur and phosphorus, and he specified a certain amount of silicon according to the process he was going to use it in, and he burnt everything out but the sulphur and the phosphorus, and put in the amount of carbon he required. In the foundry they had to buy irons different in composition and mix them to get any definite composition they required. But where steel makers bought by analysis, the founder usually got iron that did not suit him. (Laughter.) But that was not saying that iron unsuitable for the steel maker was not suitable for the foundry. It depended entirely what class of casting they were making. If the sulphur was too high for the steel maker it might do for the foundry. There was a great prejudice against sulphur. But sulphur was a necessary constituent and his experience was that it was really a controlling constituent. As to the demand for analysis only in grading, he was afraid that was not likely to come for a bit. There was no possibility of iron being sold on analysis because the blast furnace people could not make iron unless they could have the limits wide enough, and they would have to be very wide to suit some blast furnace men. (Laughter.) As to chilled cast iron, any one selling chilled iron would have to sell by analysis, there would be no system of selling partly by analysis and partly by fracture with that class of iron. At the same time he would reply to Mr. Riches by saying that after sand-cast iron and chilled-cast iron was melted there would be no difference. The result would be identical. He had used a certain quantity of that iron. As to the carron which was of a dark gray, a metal high in total carbon was usually darker in grain than an iron low in total carbon. As to Mr. Cannell's question about the effect of manganese on the grading, they might get a No. 1 with 1 per cent of manganese and the same iron with 2 or 3 per cent of manganese, and the same with No. 3 forge, and it would show no difference in the grading. It was the difference of combined carbon and high manganese which had a greater effect on carbon than low manganese. But that did not affect the size of the grain on which the grading depended. Mention had been made by Mr. Pilkington of the fact that fast driving did not give high silicon. His own impression was fast driving reduced the total carbon, and a reduction in the total carbon meant that the iron looked closer in grain. If they put more coke on they raised the silicon at the expense of the total carbon. But if they put in more ironstone they would get a better looking iron. They expected where they used excessive coke and a lower amount of limestone to see a dryer and closer appearance in the iron produced.

The chairman proposed a vote of thanks to Mr. Munnoch for his exceedingly interesting paper, the resolution being heartiy carried. The convention then adjourned.

TRADE PUBLICATIONS.

The Westinghouse Electric Mfg. Co., Pittsburg, Pa., has just issued a standard size (6 x 9), 16-page catalog describing its direct and alternating current motors for all classes of service. It also includes the starting and controlling devices.

The Stanley Electric Mfg. Co., of Pittsfield, Mass., has issued a standard size (6 x 9), 16-page catalog describing its Type K arc lamps. These are of the enclosed arc pattern.

The Hanna Engineering Co., of Chicago, Ill., is sending out a new edition of its catalog No. 3. This is standard size (6 x 9) and contains 36 pages of matter devoted mainly to a description of the Hanna riveting machines.

The Joseph Dixon Crucible Co., of Jersey City, N. J., has issued a 12-page catalog, 3½ x 6¼ inches, describing its line of graphite brushes intended for electric motors and generators. These brushes are said to possess marked advantages over the ordinary carbon brushes, as they do away with the necessity of the lubrication of the commutator with oil or grease, reduce friction, and very greatly reduce the wear on the commutator, thus increasing its life.

THE INFLUENCE OF DIFFERENT ORE MIXTURES ON THE RESULTANT PIG IRON FROM THE STANDPOINT OF THE FOUNDRY.*

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It would have been more in line with the subject matter of this paper to have made the heading read: "The Influence of the Chemical Constituents of Different Ore Mixtures on the Resultant Pig Iron, From the Standpoint of the Foundry." Every foundryman knows, in a general way at least, the influence that the elements Silicon, Manganese, Sulphur and Phosphorus, exert on the pig iron and castings produced therefrom; that higher Silicon forces the Carbon out of combination with iron and causes it to assume the free or praphitic form, thus avoiding in a measure the hardness caused by the compounds of iron and Carbon, producing castings that may be more easily machined; that Manganese exerts the opposite effect, facilitating, while the iron is molten in the furnace, the absorption of Carbon, and increasing the quantity of Carbon which will combine with the iron, which may either be a strengthening influence within limits, or hardening influence, depending on the heat treatment the iron receives; that Phosphorus makes iron fluid and acts in the same manner, but in a less degree, as Silicon does toward Carbon; that Suiphur hardens iron and makes a casting less dependable, particularly sensitive to shock, and more likely to crack or check.

The writer is of the opinion that the influence ores exert on the pig iron made from them is due almost entirely to the percentages of Phosphorus, Sulphur and Manganese they contain and contribute to the pig iron made from them; that is, by changing the percentages of these elements in our ore mixtures we can, with other conditions all the same, produce pig iron having an entirely different character. There are of course other influences in pig iron manufacture that affect the quality, grain and uniformity of the product. It is necessary in order to have a uniform iron to have the furnace work smoothly. Slips of stock, scaffolding, stops of long duration, leaky water conditions, affect the quality and uniformity of the iron by reducing the temperature of the hearth of the furnace, thus lowering the Silicon and Manganese and raising the Sulphur and this, with the percentages of Silica, Phosphorus, Manganese and Sulphur in our charge remaining the same.

In order to better understand this we take charge of stock just as it is filled, and analyze its make-up:—

6,000 lbs. Coke.
12,000 lbs. Ore.
3,000 lbs. Limestone.

The above all contain, in varying proportions, compounds of Sulphur, Phosphorus, Manganese and Silicon, and with no disturbance in the furnace, the Manager can prophesy with reasonable certainty and closeness from analyses of this charge what the resultant pig iron will analyze, as he knows that, with a carefully burdened and normal working furnace, nearly all the Sulphur will go with the slag; that approximately 85% of the Manganese will be found in the pig, together with practically all the Phosphorus. The Silicon content will be governed entirely by the hearth temperature, rate of driving, proportion of fuel to total charge, temperature of blast and amount of moisture in the air, regardless of the amount of Silicon compounds in the charge. We are of course taking for granted that enough Silica exists in the charge to form with the lime, a good volume of slag to purify the iron by filtration and to allow the furnace to work free and keep the bosh walls clean.

It is not my intention to elaborate on furnace practice except to bring out as clearly as my ability and time permit, the fact that there is an influence exerted by the four influential elements on iron directly or through Carbon to the iron indirectly and that given the same furnace and foundry conditions this influence will be positive and uniform. So if we have an iron lacking fluidity we can remedy it by Phosphorus, tone up the life of the iron by additions of Silicon, add to its density and strength by Manganese, and avoid additions of Sulphur as far as possible, by means of carefully selected fuels.

*Read at the A. F. A. Convention, Cleveland, O., June, 1906.

I think much doubt has surrounded many foundry experiments because of the addition unintentionally of elements other than those desired. In other words there was a lack of knowledge of or consideration for all the ingredients charged to remedy a difficulty. For instance, the iron has shown a sluggish tendency, or possibly an intricate casting suggests the use of high Phosphorus and Silicon, cold short (High-Phos.) pig is added without considering that there may be other ingredients exerting different influences contained in that pig iron, or possibly without due allowance for a weakened casting, for neither the Phosphorus or the Silicon add strength, both in fact have an opposite tendency. Or high-Silicon pig may be used to help out the machining cost at the expense of strength or wearing quality, due to lack of density of the casting owing to such addition, or in adding Manganese to get strength and density we may overstep the mark and get a hard, brittle casting, for Manganese exerts strengthening influence only within certain limits. The wise physician in selecting his treatment for the patient, uses as much care in eliminating those things exerting a bad influence as in choosing those remedies he believes will counteract the disease. Should not the foundryman follow his example?

I have endeavored by the foregoing to give my views of the reasons for some irons failing and some proving satisfactory. Now as to the subject outlined by the title of the paper. We must concede that no single iron can fill all the requirements arising in a foundry and make satisfactory castings for all purposes. It follows then that a selection of several irons must be made by the founder, and it is the writer's belief that it can only be made along analytical lines, disregarding grade by fracture entirely. The manufacture for pig iron today and the location of furnaces is determined largely by the matter of freight on raw material and pig iron. The margin above cost not admitting the producer to reach all markets, he must make the iron his trade demands.

The principal source of iron ore in this country today are: The Lake Superior region; the lower grade ores of the Appalachian Chain extending from Nova Scotia through New York, Pennsylvania, south into Virginia, Georgia and Alabama, forming in the latter three states vast areas of low grade ores; the magnetites of Pennsylvania, New Jersey and New York, together with the scattered areas of Limonites and Carbonates occuring in many states, and of more or less value depending on their richness and nearness to fuel and flux. Owing to the different percentages of the four influential ingredients, viz., Silicon, Sulphur, Phosphorus and Manganese, the irons from these ores have a different behavior in the foundry and have acquired reputations for performing satisfactorily certain desired results. This I believe is in no manner due to the locality or individuality of the plant where they are made. It is influenced in a measure by the fuel and flux, as by the use of, for instance, high Sulphur coke, when unless care is observed in handling the furnace, the resultant pig will contain more Sulphur than allowable. It is possible however with careful management to use high Sulphur coke if well burned and yet produce good iron. Many furnaces by nature of their location, being restricted to the use of certain ores, can only produce iron of certain analyses for Phosphorus and Manganese, these elements being regulated almost entirely by the amount of the same contained in the materials charged. Such an iron can be depended upon with more certainty if not analyzed than one having a wider range of ores to choose from. It is possible for a furnace so located to make a pig high or low in Silicon and with high or low Sulphur, for Silicon and Sulphur are subject to control, depending on proportions of fuel and flux in furnace charge. Furnaces located where they can draw their supply from the Lake Superior region, containing as it does ore suited to the manufacture of iron for all foundry purposes, should be able to fill any reasonable specification of the founder. The different ranges there:—The Marquette, Menominee and Gogebic, known as the "old ranges," and the Mesabi of more recent discovery, contain the largest volume of the richest and best working ores, for all purposes, insuring a certain supply for the next forty or fifty years with allow-

ance for increase in consumptive capacity. To this, as a possible source, can be added the leaner higher-Phosphorus ores of Minnesota and Wisconsin, just now being prospected, the extent of which is not at present known. They extend over large areas and doubtless aggregate large tonnages There are moreover being shown up by the industrious prospector evidences of other districts in Northern Minnesota and Canada, which will be tributary to the Lake region for shipment, and available as supply for furnaces using Lake ores.

The above ores, classed as "Lake ores," are almost entirely hematites, with some magnetites and limonites. In Wisconsin are found some fossiliferous ores. Most Lake Superior ores are low in Phosphorus, more than half the tonnage going into Bessemer iron. The Menominee and Marquette Ranges supply the bulk of the ores high enough in Phosphorus to produce neutral foundry iron. These, used in connection with the more chiefly mined ores from the Mesabi Range, produce most of the foundry irons made from Lake Superior ores.

Lake Superior hematites work smoothly in the furnaces. Some little trouble was experienced working the finely divided ores from the Mesabi Range when they were first used, but practice has been adjusted to these ores, and no difficulty aside from dust losses is now encountered. The deposits on this range are the largest in the world now opened, and there will be shipped from this range before it is exhausted over one billion tons of ore. Nowhere has Nature been kinder to the metallurgist than to the producers of iron in that region where Lake Superior ores are smelted with Connellsville coke.

The pig irons made from certain kinds of ore, such as Carbonates, Limonites or Magnetites, have at different times been supposed to possess particular merit, or to accomplish certain desired results in the foundry. The writer believes the happy blending of certain chemical elements is responsible for this. We do know that certain ores work well in the furnace—that is, absorb Carbon and the reducing gases in the furnace readily, due to their porosity or to the expulsion of carbonic acid and water, thereby decrepitating and affording channels for the reducing gases to penetrate, thus being reduced to iron throughout the mass. This being true we should expect the porous hematites, the carbonates and limonites, to work the best. This is the case, and irons with especially good reputations are made from them. Magnetites, specular hematites and dense hard hematites must proceed through the furnace more slowly, and attempts to drive them too fast result in bad working of the furnace. Magnetites are particularly hard to reduce, due largely to their density, admitting of superficial reduction only. Mill or puddle furnace cinder reduces in this manner in a more marked degree, and has a melting point so low that frequently causes bad or irregular working by melting before entirely reduced. Mill cinder is moreover usually irregular in composition, and in general tends to irregularity in chemical composition of iron made from it. We think therefore the existing prejudice against cinder iron has some justification.

While we believe chemistry will explain the failures and disappointments encountered in the foundry, it can only do so with the co-operation of the intelligent founder—the man whose judgment guides the operation of the cupola, and directs methods and manner of pouring and molding, who selects as carefully his other materials as he does his pig iron. It has always seemed to the writer extravagant to the point of folly to pay high prices for charcoal Iron and melt it with coke, and poorly selected coke at times. Would it not be more reasonable to use an ordinary iron and re-melt with charcoal to get the same result, or re-melt charcoal iron with charcoal if very low Sulphur is necessary in the casting. Pig iron made with charcoal is preferable for some purposes to the coke product, for the reason that in general lower Silicon iron can be produced with charcoal, without having high Sulphur, thus getting an iron that will chill but not be weak.

The balance maintained by the Silicon, Sulphur, Phosphorus and Manganese is of vastly more importance than the exact percentage of any single element. The total Carbon in foundry iron does not

vary greatly, different pigs from the same cast are likely to vary as much as pigs from entirely different furnace plants. An experienced chemist, given Silicon, Sulphur, Phosphorus and Manganese, can estimate the combined and Graphitic Carbon close enough for foundry purposes.

It is well known that certain brands of iron have deservedly good reputations in the foundry, when other brands, occasional samplings of which show approximately the same analyses, fail. I am of the opinion that this good reputation is acquired by care in the operation of the furnace—keeping uniform the blast pressure, temperature and furnace burden, thereby insuring uniform iron, using care in piling and selecting iron according to analyses, shipping iron according to specifications, and keeping in touch with the consumer to learn his needs. While the chemical influence of the elements Silicon, Sulphur, Phosphorus and Manganese is always fixed, there must of necessity be uniformity of analyses within reasonable limits, in irons having the same name or grade, if good results are to be expected, hence the necessity for analyzing each cast and keeping intelligent record of same, and of marking and numbering the casts where piled. After an experience of 20 years as furnace chemist and superintendent, I am positive that grading iron by fracture is a very dangerous and costly practice for the founder. I can readily see why the furnaceman should prefer it. Combination grading by fracture and by analysis is not fair to the furnaceman. I have frequently seen specifications of this kind so conflicting as to render the proper and honest filling of the order impossible. We never hear of fracture in the steel-making iron trade, the influence of the chemical elements is taken as an axiom. Neither is there any attention paid to the ores or other materials from which the iron is made, simply the hard and fast rule that certain chemical specifications must be adhered to.

To sum up the matter outlined by the title. Given an ore mixture of proper chemical composition for making satisfactory iron, no further benefit can be transmitted to the iron by the ore than that which comes through regular uniform working of the furnace. Judging iron by that mysterious ingredient variously denominated as character, body, physical properties, etc., and which is supposed to find expression in the color and grain of the pig, bears about the same relation to intelligent foundry practice as the Indian medicine man does to the educated physician. We have the best ores, fuels and fluxes of any nation on earth, let the founder and furnaceman join hands, dismiss prejudice and superstition and attack the proposition along scientific lines, and together work out the destiny nature has shaped for them.

HUNTING FOREMAN MATERIAL.

BY OSCAR W. BURNS.

The regular foundry foreman had found it necessary to be absent for a few days and one of the molders looked after things in his absence. As everything had been running smoothly for some time it was easy for almost any one to do this, and things went almost as well as if the regular man had been there. The "old man" did not expect anything else, but this fact of his foreman being away set him to thinking of the men in the shop and he was forced to the conclusion that if his foreman should leave for good he did not have a man competent to fill his place.

He spent part of his time each day around the foundry, and some of that time was spent in studying over the make-up of his leading men. The man who was looking after things was a capable man. He understood his business well, but he lacked backbone. If he had a run of bad luck with his own work instead of bracing up and ferreting out the cause he was likely to go on a spree. When in charge he interfered as little as possible with the actions of the men, and it was plainly to be seen that the discipline of the shop was not up to the standard when he was in charge. It was likely this in his make-up that

prompted him to suggest to the owner that the next time that the foreman was away it might be a good thing to put Hale in charge. "Do you think that Hale is as good a man as you are?"

"He has been here longer than I have been, and he thinks that he should be given a chance at it."

"Do you think that he is capable of running a foundry? Has he the knowledge outside of molding that a foreman must have to get along?"

"It's hard to say what he thinks, but I know he acts in a way that makes it mighty disagreeable for me. And from what he says to the men he can do a lot better than I do. I don't think he is anything extra even as a molder, and I would like to see him get into a place once where he would not have anyone to hold him up and tell him what to do and see how he would get along. I have an idea that it might take a bit of the conceit out of him."

The "old man" turned the matter over in his mind for some time. He had known Hale for several years and had never supposed that he had any aspirations higher than being a molder; in fact, he did not think that he even wanted to be a first-class molder. He was a hard worker, but always seemed to get along best on the jobs that took a lot of hard work but did not require a high grade of knowledge or skill. Not wishing to have a dissatisfied man on his hands if he could help it he decided to have a talk with Hale if the opportunity should offer.

Some time after this a friend wrote to him and wanted to know where he could find a foundry foreman, and the "old man" thought of Hale, and thought that this might be a good chance to draw him out. By this time the regular foreman had returned and from him it was learned that the temporary foreman had not been mistaken in the estimate which it was believed Hale had of his own ability. "He has given me to understand more than once that if he was running things here some of the men would have to stand around in a different way."

"Mr. Hale, I would like to have a talk with you in the office for a few minutes, if you can spare the time."

Hale laid down his tools and went along.

"I have an inquiry from a friend who is in need of a foundry foreman. How would you like such a job?"

"I would like it. What is he willing to pay?"

"It is not a very large foundry. I think he pays twenty-five dollars a week."

"That is better than 29 cents an hour."

"You think you could run it successfully, do you?"

"O! I could run it. Any man that stayed around me would have to do a day's work. I know some men not a thousand miles away that I wouldn't give a job to."

"It is fortunate that there are places in some foundries for men who are not first class. If it were not so it would go hard with quite a lot of men who are now working one place and another. Now before I can recommend you to my friend I would like to know how much you know about a foundry besides the molding and pouring off. I have never had any experience with you outside of the work you have been doing, and so I would like to ask a few questions. I will take it for granted that you know all about molding different kinds of work, and can tell how heavy a big flask full of sand is and how heavy a chain it would need to safely handle it, and the best mixtures for cores of different sizes and shapes, and all about the sands and the way they should be handled and rammed for different kinds of patterns. What do you know about handling the cupola?"

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"How do you mean?"

"My friend has a 36-inch cupola. How would you charge it and how much iron would you figure to get out of it an hour?"

"I would have to look some of the things up in a book that I have over at the house. It tells all about the charging, but I could get about three tons out of it. That is what they used to get one place where I worked."

"How many pounds of iron should it melt to a pound of coke?"

"I have heard a good bit of talk about that, and everybody has their own ideas, but I know I could do as well as anybody else as soon as I got my hand in once."

"How would you arrange the different irons so as to get the kind that was wanted in the castings?"

"I'd mix the pig iron and the scrap, and if the castings came too hard I would use more pig, and if they came too soft I would use more scrap."

"Suppose you had several kinds of pig iron. What would you do then?"

"The owner would have to look out for getting good iron. He is the man that has to buy it."

"If he should ask you what kind you wanted, what should you tell him?"

"I can't give you the names of the irons off-hand, but I can easily get them. I would tell him to get the best ones. Lots of foundries use No. 2 iron and some even try to use No. 3. I believe you tried some here once when you were out of scrap, but it gave trouble. Of course No. 1 is the best if the firm can afford to get it."

"You know, of course, that iron has carbon, and silicon, and sulphur, and phosphorus in it, and that they are different in different brands of pig iron. If you had to keep the percentages of these things within certain limits, and was given the analysis of a lot of different irons could you select the proper ones to mix and get what would be needed?"

"I know that there are all kinds of iron, but that isn't the fault of the molder. If the owner wants anything fancy let him figure it out, he has nothing to do but to figure out that sort of thing while he is sitting around in the office taking it easy." The "old man" had a vision of how easy it was to sit in the office and try to urge delinquent debtors to come to the front before the next pay day. "If a foreman is not willing to take off his coat and do his share I suppose it is very nice to be able to talk of these kind of things and make marks on paper, and try to make folks think that he knows as much as a college professor." The look that was directed on the row of books on the desk did not leave much to be inferred. "I never was afraid of work myself."

"I do not think that my friend is so particular as to the amount of work his foreman tries to do in the way of molding as he is about the results which come from the work of the other men. If a foreman plans the work for each man, and sees that it is done correctly; keeps the costs of the work down to a commercial basis; keeps his heats so planned that each job gets the right kind of iron; keeps track of his stock so that there is always a supply of everything on hand, and yet not any unnecessary money tied up; plans ways of doing work so that it is done in the best, safest, and cheapest way; enforces discipline so that every man keeps his own place and is orderly, but does it in a way that everyone is cheerful and feels that he is being used rightly; keeps in touch and works in harmony with the machine shop and the pattern shop; gives the office accurate information as to the cost of new work, and the time of delivery of any orders on hand; educates some willing man up to the point where he can look after things for a few days; informs himself as to the methods in use in other places so that he can have a basis of planning possible improvements in his own work; in fact, if he is a live man with good foreman timber in him, he has very

little time to spare. He may be able to find time to show some man or boy about a new job, or to try some new plan which he wants to be sure about owing to the conclusions to be drawn from it, but if he tries to make a hand of himself, it is either a small foundry or else it is expensive for the firm."

"I supposed that a company wanted a man who was not afraid to get at it and hustle," said Hale, who seemed to feel that the above was in some way a reflection on himself.

"They do, Mr. Hale, they do, but—" and he paused so that his words could have full weight; "bodily activity is not always business hustle. Even among the laborers around a foundry there is a difference, and it is brains that counts. Results are the only things that a firm can sell, and it takes a lot of thinking to get out results that can be sold at a profit, and even a good foreman has not time to do it all."

There was further talk, but the foreman was gotten from some other place. Hale's idea of learning seemed to be to get at a new job and have some one "break him in" at it. This may do for the simple jobs where a man works at the same thing for a long time, but he did not seem to get the idea that education comes from the inside, and that the first thing was a desire to know, and a reaching out of the mind. He did not take in the idea that there should be a constant activity of the mind, a balancing and reasoning on cause and effect, a weighing of past experiences and their relation to present results that makes a new job something that can be undertaken without "breaking in." A new job, as a problem, did not appeal to him. He could only work it out by one method, and that was by elimination. The first casting might be bad from several causes, the next one had fewer causes, and by and by, after several bad castings the bad causes were met and conquered and good work began to come. If changed to another dissimilar job the same process had to be gone through with. Naturally the foreman made as few changes with him as possible, and when he had to do it, kept a very close watch for a few days. He had to furnish most of the brain work.

THE ORIGINAL FOUNDRY FACINGS MILL.

The mill in Peekskill, New York, operated for nearly forty years by Robert MacKellar and recently rebuilt by the R. MacKellar Sons' Co. is the cradle of the facings industry in this country. Within its walls were developed the first formulas for mold coatings which could be depended upon to produce a smooth casting. The facings business was organized and classified into a definite industry and the different kinds of facings now in daily use were worked out in its modest office. The works under the management of W. H. H. MacKellar, the son of the original manufacturer of MacKellar's facings, are still turning out the old familiar brands and are grinding more material than the founder would have thought possible. Several of the brands supplied by other firms are ground in this mill.

The original facings mill was originally not a facings mill at all. Instead of the black charcoal dust which now passes through the bolting machine, the primitive stones turned grain into grist, and white flour sifted upon the clothing of workmen. The elder MacKellar died in 1901 and the next year the quaint old mill was burned. It was a picturesque old structure, four stories high, with oddly shaped gables, windows stuck here and there at random, and a double Dutch door with a round hole in the lower half for the convenience of the cat. Its machinery was of the same quaint character, the shafting being in the form of huge beams of wood fortified at the bearing ends with iron gudgeons. Wooden gear wheels added their rattle to the whirr of the mill and the power was generated by three rustic water wheels, two arranged in tandem formation, one above the other, a pair of twenty feet

in diameter dividing between them the forty-foot fall. Another wheel of larger diameter completed the first power equipment. Now there are modern turbine wheels and a steam plant to turn the wheels when the water in the old dam in Anville Creek runs low.

The old mill, no doubt, played its part in the American Revolution, for Peekskill long lay in the contested zone between the British and patriot lines. Tradition has it that bags were filled there more than once for which no accounting has ever been rendered. However, that has nothing to do with foundry facings.

a matter of luck tempered by chipping tool and file. They demanded a smooth stove plate direct from the mold and came to the old mill to help them out.

In 1837, one of the stove founders of the neighborhood brought sundry samples of soapstone to the mill then owned by one John V. Smith. The resulting powder proved to be fireproof, smooth and non-adhesive, and the manufacture of facings began. At first the soapstone rock was brought by wagon over the hills from Connecticut from a farm owned by a Yankee named Ferris—time has obliterated the initials.

About the same time, or perhaps a

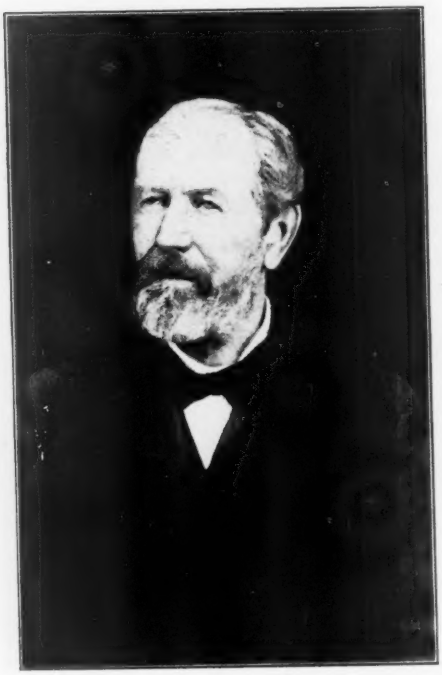
THE PRESENT MACKELLAR FOUNDRY FACINGS MILL.

In the early part of the last century Peekskill was the center of great activity in the iron industry. Previous to the year 1830, a thriving foundry business had sprung up there, drawing supplies from the blast furnaces planted along the slope of the Hudson river bank. In those days the town was famous for its stoves, its ploughs and its platform scales. It still has reason to feel proud of its stove industry which now thrives on metal shipped in from distant points. The ironmasters of the old days were a peculiarly wide-awake lot, and it was their dissatisfaction with methods as they found them that paved the way for the perfection of modern foundry facings. Before their day a smooth casting was

little before, Smith began to grind "sea coal" from Scotland for facings, the product being shipped chiefly to a house in New York named, Boyd & Pease. Along about 1844, Coffin S. Brown, a local foundryman, induced the owner of the mill to aid in a series of experiments with anthracite from Lehigh Valley, Pa. The powder was dusted on the mold with a bag and proved to be a great improvement. Later trials with mixtures of soapstone and Lehigh coal yielded still more satisfactory results and paved the way for the development of a successful heavy facing mixture.

Subsequently the old mill passed out of the hands of the illustrious Smith and came into the possession of David

Mandeville, Charles Quinn and Conrad Quinn. During their reign, foundrymen began to realize the need of more than one application of facing powder. Shortly after 1855 two different kinds began to be used, a heavy facing of soapstone and Lehigh coal for the fireproof ground and a top dressing of powdered charcoal. These men extended the research into the subject and produced a fairly good facing, in the modern sense, by adding a peculiar variety of fireclay which they dug out of the bank beside the mill. In those days the most satis-



ROBERT MACKELLAR.

factory results were obtained by the use of a heavy facing containing about 80 per cent Lehigh coal, and 10 per cent each of soapstone and clay, covered with a top dusting of charcoal.

But the enterprising trio seem not to have been successful financially, for the mill passed out of their possession into the hands of a mortgagee, Joseph L. Cook, a manufacturer of ploughs. He sold the property to Robert MacKellar, the real founder of the facings industry in this country. This was in 1862, and immediately what had hitherto been merely a desultory custom grinding business began to shape itself into a definite industry.

Robert MacKellar was a remarkable man in many ways. He was fond of books and had in his youth been apprenticed to a painter. A portrait of the boy painted either by his own hand or by the master still adorns the office of the mill. The new owner was interested in science and he spent much of his spare time in a laboratory which he fitted up largely with his own devices. There he tested the minerals of the neighboring country and with the aid of a crucible and a fire, like the alchemists of old, he added much to the knowledge of local economic geology. He discovered the presence of emery in the rock strata in the vicinity of Peekskill and also graphite which he promptly put to practical use. It was he who first suggested that something besides oyster shells might be used to flux a cupola. He placed upon the market a flux of his own which became famous among the foundrymen of the Hudson river valley as "Endolithic Marble." He also developed local beds of fluorspar and introduced the use of that flux into the foundries of the vicinity. Among the more notable of his other inventions is the well-known pipe heater used in connection with stoves and the original heater of this type made fifteen years before the device appeared upon the market, was in use about the mill until very recently.

Robert MacKellar soon saw the latent possibilities of the business which he had purchased. He began to attend conventions of foundrymen, to create a name for his goods and to apply principles of science to the manufacture of facings. He began to adapt certain kinds of mixtures to certain kinds of work and adopted definite methods so that the element of chance disappeared and the results gained were invariably those sought. The business grew rapidly and in a comparatively short time the old mill

supplied all the foundries in the country as far west as Detroit. All the big stove makers of the sixties and seventies employed the MacKellar facings.

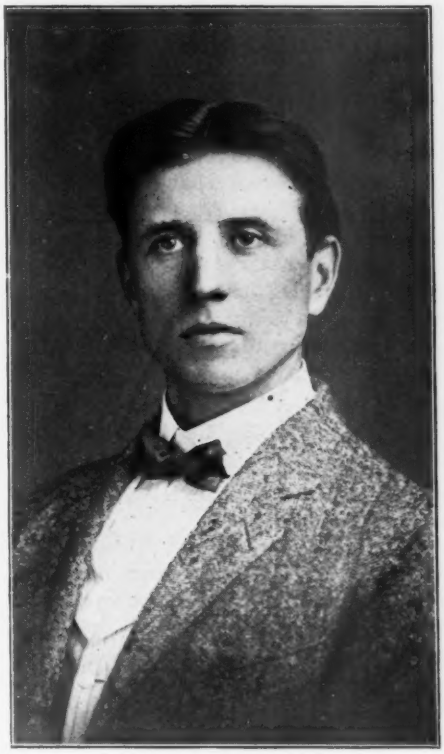
In those days the mill never ceased grinding day and night. It became a serious question to get enough packing cases in which to ship the output, and all sorts of barrels, boxes and even fish hogsheads were pressed into service. Modern methods of advertising had not yet been developed and news of the excellence of a product traveled by slow and natural routes. Mr. MacKellar's best advertising agent was the peripatetic molder who then as now migrated hither and yon, and by telling his new boss of the great things done elsewhere with improved facings he spread the demand.

Long before this time the power furnished by the old water wheels had become inadequate and a supplementary steam engine had been installed. The first engine used to drive the machinery was an early type of walking beam engine, one which had seen service in the hull of a steamboat probably plying between points on the Hudson. Copper and brass seem to have entered very largely into the construction of these old-time prime movers for when Mr. McKellar dismantled the old engine to make room for one of more improved type he sold the scrap copper and brass for about $800.

From 1880 on the business began to feel the effects of competition and distant demands began to be supplied from nearby sources. Perhaps the man who had developed the industry had an old-fashioned dread of advertising or he may have been philosophically content with the cares of a modest establishment. Anyhow for the declining years of his life his enterprise was confined to a comfortable local business and the mill supplied only a comparatively small territory.

On April 1, 1901, Robert MacKellar died and on April 1, 1902, the old mill was razed to the ground by fire. The heirs of the estate selected W. H. H. MacKellar to rebuild and manage the plant. Young MacKellar is a son of his father. He possessed the enterprise of youth and had gathered new ideas from the big world which lay beyond the borders of Peekskill. He had for some years been engaged in journalism, having served time on some of the big metropolitan dailies of New York. He saw an opportunity to restore the original facings mill to its place of supremacy in the trade of the country. He enlarged the capacity of the mill along modern lines, and has been compelled to build other additions to supply the demand which promptly came.

"The only mistake I made," said Mr. MacKellar, "is that I did not build large enough."



W. H. H. MACKELLAR.

The new mill produces more facings than the founder would have thought possible. Besides the well-known MacKellar brands, large quantities are being ground for the trade at large, product which reaches the trade under other labels. Efforts are directed especially to the development of charcoal products of which a great variety

are manufactured. The familiar stove plate facings and heavy facings of the firm are, of course, made in quantity, also Lehigh, soapstone and plumbago facings and a core wash. The grinding of sea coal has been abandoned for some years.

"Sea coal should never be ground in the same mill as true facings," said Mr. MacKellar. "A slight admixture is sure to occur and the result is invariably spotted castings."

Sea coal facings, he explained, are not properly foundry facings at all. They are mixed with the sand and serve rather to make the mold porous and furnish a vent for imprisoned gases. For this purpose the coal must be highly bituminous while the material for a true facing must be fire-resisting to prevent the molten iron from burning the sand. There have been a number of changes in the requirements of facings since the beginning of the industry in the early part of the last century, although the principle remains the same. The metal is run at a higher temperature now and in many other ways the requirements are more difficult to meet.

A PLEA FOR LOWER BLAST PRESSURES IN CUPOLA AND AIR FURNACES.*

BY WILLIAM H. COLEMAN, CHICAGO, ILL.

Within the remembrance of our older foundrymen there was a time when blast pressures of 22 to 24 ounces at the wind box and in the supply pipe to the cupola were deemed necessary to melt iron and to make good castings. Although considerable changes have been made, tending to increase the capacity and economy of cupola practice, yet some foundrymen adhere to what may be termed high blast pressures.

Modern practice calls for greater height of charging doors from bottom of cupola, larger wind box and greater tuyere area, together with larger pipe for air supply. Formerly where coal was used in cupolas, the fuel ratios predominating were as high as six and five to one, and the total tuyere area ranged down to as low as 10 per cent of the area of the cross section of the inside lining of the cupola.

In those days even with the high blast pressures then used, clogging of the tuyeres was quite commonly observed. In a cupola of 48-inch diameter inside the lining, we would have a cross section of 1809.56 inches. The area of the tuyeres would equal about seven per cent of this or 126.66 square inches. In order to force the required amount of air through this restricted area, a comparatively high pressure of at least 16 to 18 ounces was required, but by doubling this tuyere area either by putting in more tuyeres or having them larger, up to 20 or even 25 per cent of the cross section of the inside diameter of cupola, a lower blast pressure can be used, the volume of air remaining the same. Table No. 1 clearly indicates the rapid increase in friction resulting from higher velocities. It is a convincing argument in favor of large areas and low velocities. This table is from a catalog of the B. F. Sturtevant Co., and is for pipes 100 feet long.

In order to get a large volume of air through restricted tuyere area the blast pressures must be correspondingly high. The prominent cupola builders recognize that enlarged tuyere area is an advantage, but some of them continue to recommend higher blast pressures than are commonly used among the best informed cupola managers. The substitution of coke for coal, as a fuel, seems to make larger volumes of air necessary, and the soft by-product coke, while having the properties of an ideal cupola fuel, must be mixed with the harder cokes, and requires more oxygen than the hard cokes of the east, and therefore more air to make it melt iron rapidly.

Recent changes in methods of charging the cupola, and the better attention which the makers have given to teaching foundrymen how to use by-product coke have brought about better fuel ratios and other improved conditions.

*Paper read at the A. F. A. convention, Cleveland, June, 1906.

It is now undoubtedly the best practice to use lower blast pressures to such a point as the consequent lower capacity will admit of. It is, of course, agreed that if capacity only is to be considered, then the higher blast pressure must be employed.

High and Low Blast Pressures for Air Furnaces.

In speaking of this subject here I do so for the reason that many members of this association operate both the cupola and the air furnace. I find the air furnace operators are greater sinners in regard to high blast pressures than the cupola men.

The correct volume and blast pressure for air furnace work depends upon the rate of coal consumption on the grate per square foot per hour and the quality of coal used. Heed should be paid to whether the coal is heaped high on the grate and whether or not the furnace is crowded.

The air supply pipes under the grates and those for the top blast should be of ample size and fitted without abrupt curves or elbows. In this way low blast pressures may be utilized, and consequently considerable power may be saved, as is shown in the following table which compares the steel pressure blower having small volumetric capacity, with the low pressure fan having large capacity at a lower pressure.

It is quite evident that the low pressure type of fan is the more economical for air furnace work.

I believe that in an air furnace under proper working conditions there is little reason for the down blast through small thimbles to support combustion where the volumes and velocities of the air under the grates are proportionally arranged. If the thimbles are enlarged up to at least three inches diameter in the eight-ton furnace, and at least four inches diameter in the ten-ton furnace and are fitted to a supply pipe with a funnel or gradual taper, and if they are of sufficient number, they will offer very little frictional resistance to the air. If all these conditions are fully met there will cease to be any reason for high velocities or high pressures of air in this type of furnace. You can blow more of a flame down by four thimbles of 3-inch diameter at two ounces pressure than with five thimbles of 1½-inch diameter at six ounces pressure because the combined thimble or tuyere area is greater.

To pass 100 cubic feet of air per minute through a pipe whose diameter is 2½ inches, requires an air velocity of 3,000 feet per minute. While through a 4-inch pipe with a velocity of 2,300 feet per minute, double the amount of air may be passed.

The experience of our fan engineers, (fan engineering is now recognized as a distinct and special line of engineering) show that 200 to 300 cubic feet of air is required to burn 1 lb. of coal, and that the pressures should be 1¾ to 2¼ ounces under the grate for air furnace work. Assume 20 to 40 pounds coal per square foot of grate and allow 15 to 25 per cent additional air for the down blast, and make openings and pipes of ample area, letting the air for down blast be supplied at same pressure as that below the grates. Under this change of conditions from high velocities of air through small thimbles, some of your air furnace tenders will complain of not getting enough pressure. Strange, they never complain of "not getting enough air." They seem to think that if the air with its high velocity rushing through the small orifices "whistles," everything is all right. Now, this is one of those "whistles" that comes high. If you must have air and plenty of it in your down blast, make your openings large and use the proper type of fan: The volume fan and not the cupola fan.

"The introduction of this down blast throws the flame over on to the iron in the bath," says our air furnace man. It seems to me that the use of this down blast at high pressure is one of the reasons why the ratio of fuel to metal is 60 per cent instead of 30 per cent, which is at least the theoretical ratio. Some of our largest makers of gray iron castings have been frightened

TABLE NO. 1.

PRESSURE AND HORSEPOWER LOST BY FRICTION OF AIR IN PIPES 100 FEET LONG.

DIAMETER OF PIPE.

Velocity of Air in Feet per Minute.	11-inch.		12-inch.		13-inch.		14-inch.		16-inch.		18-inch.		20-inch.		22-inch.		24-inch.		26-inch.	
	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.
100	0.001	0.0000	0.001	0.0000	0.001	0.0000	0.001	0.0000	0.001	0.0000	0.001	0.0000	0.001	0.0000	0.001	0.0000	0.000	0.0000	0.000	0.0000
200	0.004	0.0001	0.004	0.0002	0.003	0.0002	0.003	0.0002	0.003	0.0002	0.002	0.0002	0.002	0.0003	0.002	0.0003	0.002	0.0003	0.002	0.0003
300	0.009	0.0005	0.008	0.0005	0.008	0.0006	0.007	0.0006	0.006	0.0007	0.006	0.0008	0.005	0.0009	0.005	0.0010	0.004	0.0011	0.004	0.0012
400	0.016	0.0012	0.015	0.0013	0.014	0.0014	0.013	0.0015	0.011	0.0017	0.010	0.0019	0.009	0.0021	0.008	0.0023	0.007	0.0025	0.007	0.0027
500	0.025	0.0023	0.023	0.0025	0.021	0.0027	0.020	0.0029	0.017	0.0033	0.016	0.0037	0.014	0.0041	0.013	0.0045	0.012	0.0050	0.011	0.0054
600	0.036	0.0039	0.033	0.0043	0.031	0.0046	0.029	0.0050	0.025	0.0057	0.022	0.0064	0.020	0.0071	0.018	0.0079	0.017	0.0086	0.015	0.0093
700	0.049	0.0062	0.045	0.0068	0.041	0.0074	0.039	0.0079	0.034	0.0091	0.030	0.0102	0.027	0.0113	0.025	0.0125	0.023	0.0136	0.021	0.0147
800	0.064	0.0093	0.059	0.0102	0.055	0.0109	0.051	0.0118	0.044	0.0135	0.040	0.0152	0.036	0.0169	0.032	0.0186	0.029	0.0203	0.027	0.0220
900	0.081	0.0132	0.075	0.0145	0.069	0.0157	0.064	0.0169	0.056	0.0193	0.050	0.0217	0.045	0.0241	0.041	0.0265	0.037	0.0289	0.035	0.0313
1,000	0.101	0.0182	0.092	0.0198	0.085	0.0215	0.079	0.0231	0.069	0.0264	0.062	0.0297	0.056	0.0330	0.051	0.0364	0.046	0.0397	0.043	0.0430
1,100	0.122	0.0242	0.112	0.0264	0.103	0.0286	0.096	0.0308	0.084	0.0352	0.075	0.0396	0.067	0.0440	0.061	0.0484	0.056	0.0528	0.052	0.0572
1,200	0.145	0.0314	0.133	0.0343	0.123	0.0371	0.114	0.0400	0.100	0.0457	0.089	0.0512	0.080	0.0571	0.073	0.0628	0.067	0.0685	0.062	0.0742
1,300	0.170	0.0399	0.156	0.0437	0.144	0.0472	0.134	0.0508	0.117	0.0581	0.104	0.0654	0.094	0.0726	0.085	0.0799	0.078	0.0873	0.072	0.0944
1,400	0.198	0.0499	0.181	0.0544	0.167	0.0589	0.156	0.0635	0.136	0.0726	0.121	0.0816	0.109	0.0907	0.099	0.0998	0.091	0.1088	0.084	0.1179
1,500	0.227	0.0613	0.208	0.0669	0.192	0.0725	0.179	0.0781	0.156	0.0892	0.139	0.1004	0.125	0.1115	0.114	0.1227	0.104	0.1339	0.096	0.1450
1,600	0.259	0.0735	0.237	0.0812	0.219	0.0880	0.203	0.0948	0.178	0.1083	0.158	0.1218	0.142	0.1354	0.129	0.1469	0.119	0.1624	0.109	0.1760
1,700	0.292	0.0893	0.268	0.0974	0.247	0.1055	0.229	0.1137	0.207	0.1299	0.178	0.1461	0.161	0.1624	0.146	0.1786	0.134	0.1948	0.124	0.2110
1,800	0.327	0.1060	0.300	0.1156	0.278	0.1253	0.257	0.1351	0.225	0.1542	0.200	0.1735	0.180	0.1927	0.164	0.2120	0.150	0.2313	0.139	0.2506
1,900	0.365	0.1247	0.334	0.1360	0.308	0.1472	0.287	0.1587	0.251	0.1814	0.223	0.2040	0.201	0.2267	0.182	0.2494	0.167	0.2720	0.154	0.2945
2,000	0.404	0.1454	0.370	0.1586	0.341	0.1719	0.317	0.1851	0.278	0.2115	0.247	0.2380	0.222	0.2644	0.202	0.2908	0.185	0.3173	0.171	0.3437
2,200	0.489	0.1936	0.448	0.2111	0.413	0.2287	0.384	0.2463	0.336	0.2815	0.299	0.3167	0.269	0.3519	0.244	0.3871	0.224	0.4223	0.207	0.4575
2,400	0.582	0.2513	0.533	0.2741	0.492	0.2970	0.457	0.3198	0.400	0.3455	0.356	0.4112	0.320	0.4569	0.291	0.5026	0.267	0.5483	0.246	0.5939
2,600	0.683	0.3195	0.626	0.3485	0.578	0.3776	0.537	0.4066	0.468	0.4647	0.417	0.5228	0.376	0.5809	0.341	0.6390	0.313	0.6971	0.289	0.7552
2,800	0.792	0.3990	0.726	0.4353	0.670	0.4716	0.622	0.5079	0.544	0.5804	0.484	0.6530	0.436	0.7255	0.396	0.7981	0.363	0.8706	0.335	0.9432
3,000	0.909	0.4908	0.833	0.5354	0.769	0.5800	0.714	0.6245	0.625	0.7140	0.556	0.8031	0.500	0.8923	0.455	0.9816	0.417	1.0708	0.385	1.1601
3,200	1.034	0.5956	0.948	0.6498	0.875	0.7039	0.813	0.7581	0.711	0.8664	0.632	0.9747	0.569	1.0830	0.517	1.1913	0.474	1.2996	0.438	1.4079
3,400	1.168	0.7144	1.070	0.7794	0.988	0.8441	0.917	0.9093	0.827	1.0475	0.714	1.1690	0.642	1.2990	0.584	1.4289	0.535	1.5588	0.494	1.6882
3,600	1.309	0.8481	1.200	0.9252	1.114	1.0023	1.029	1.0800	0.900	1.2335	0.800	1.4078	0.720	1.5420	0.655	1.6962	0.600	1.8504	0.557	2.0046
3,800	1.459	0.9974	1.337	1.0871	1.234	1.1880	1.146	1.2695	1.003	1.4508	0.891	1.6342	0.802	1.8135	0.729	1.9949	0.669	2.1742	0.617	2.3760
4,000	1.616	1.1734	1.481	1.2691	1.367	1.3749	1.270	1.4807	1.111	1.6922	0.988	1.9037	0.889	2.1152	0.808	2.3467	0.741	2.5382	0.684	2.7498
4,200	1.782	1.3667	1.633	1.4692	1.508	1.5916	1.400	1.7140	1.225	1.9589	1.089	2.2037	0.980	2.4486	0.891	2.7335	0.817	2.9383	0.754	3.1832
4,400	1.946	1.5484	1.784	1.6892	1.655	1.8300	1.537	1.9707	1.344	2.2522	1.189	2.5338	1.071	2.8153	0.973	3.0969	0.892	3.3784	0.827	3.6599
4,800	2.327	2.0103	2.133	2.1930	1.969	2.3758	1.829	2.5585	1.600	2.9241	1.422	3.2896	1.280	3.6551	1.164	4.0206	1.067	4.3861	0.985	4.7516
5,200	2.731	2.5559	2.504	2.7882	2.311	3.0206	2.146	3.2530	1.871	3.7177	1.670	4.1824	1.502	4.6471	1.366	5.1118	1.252	5.5765	1.156	6.0412
5,600	3.168	3.1923	2.904	3.4825	2.680	3.7727	2.489	4.0629	2.178	4.6433	1.936	5.2237	1.742	5.8041	1.584	6.3845	1.452	6.9649	1.340	7.5453
6,000	3.636	3.9263	3.333	4.2833	3.077	4.6402	2.857	4.9959	2.500	5.7110	2.222	6.4249	2.000	7.1388	1.818	7.8527	1.667	8.5666	1.538	9.2804

away from using the air furnace to melt pig iron by reason of its high fuel consumption.

The air furnace is subject to great wear and tear; this can undoubtedly be lessened, as in the cupola, by using low pressures.

TABLE NO II.

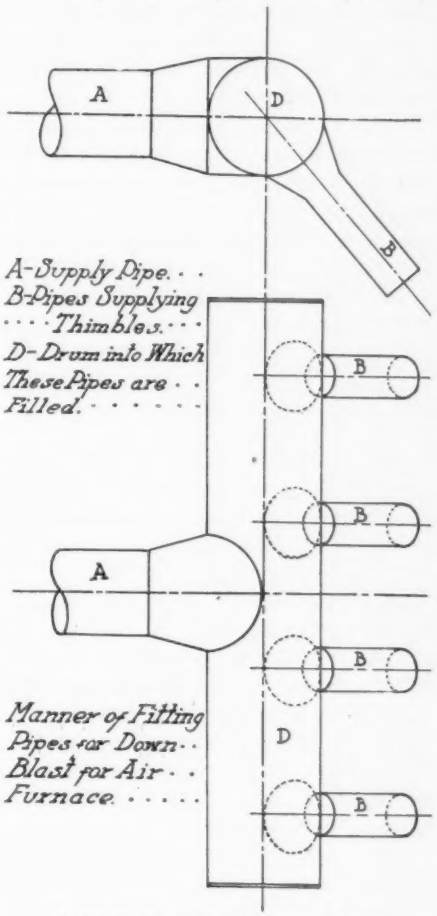
Type.	R. P. M.	Dia. Wheel.	Pressure. Ounces.	Air per min. cubic feet.	H. P.
Sturtevant Steel Pressure Blower.....	1,618	41-¼ in.	12	3,760	20.5
Sturtevant "Monogram" Blower.....	780	40 in.	2.5	10,600	12.0

I am inclined to think that if there is a sufficiency of air under the grates, and if the air spaces in the grates are proportioned properly, the combustion will be all that is required. The introduction of cold air beyond the bridge wall tends to cool off the gases of combustion and interferes very materially with the draft through the stack. We know from our laboratory experiments with a Bunsen burner, in mixing gas and air for a heating flame, that cold air will not mix readily with heated gas; when the gas gives up its heat to the air and it in turn becomes heated, then they will mix and burn without smoke or soot.

Among the many foundrymen, who, under the direction of their metallurgical chemists, have been reducing their pressures from time to time, it is a significant fact that a company in Chicago, operating probably the largest number of cupolas as well as the largest in size of any known to me, is one of the firmest believers in low-blast pressures. In one of their many plants they are using two cupolas of 84 inches inside diameter, and a centrifugal fan blower to give 24,000 cubic feet of air per minute at 12 ounces pressure, in the wind box. Another of the largest firms in this country is using six to eight ounces in two 72-inch cupolas, and with positive blowers.

The position and shape of the tuyeres sometimes play a part in the proper distribution of the blast, and their height should be determined with due regard to the character of the work done and the charging of the cupola should be changed accordingly. For heavy castings the tuyeres should be higher than for light castings, and for stove castings a very low position of tuyeres is advisable, as the melting is practically continuous.

While I am an advocate of low pressure in cupolas for the reasons above stated, I am not an advocate of scanty volume or supply of air. Many foundrymen are using blowers far below the required capacity in volume; therefore they are compelled to speed up their blowers in order to get the necessary volume, thereby getting, incidentally, higher pressures than are essential to do the work, with poor results in their products, together with rapid



BLAST PIPES FOR AN AIR FURNACE.

destruction of cupola lining. This is undoubtedly one of the most important reasons for existence of high pressures in many foundries. High pressures give a greater melting capacity for a given size cupola, but better results at a less cost for power can certainly be obtained by using larger cupolas with lower pressures and larger volumes of air supplied through enlarged tuyere area. Under some conditions the desire for a high rate of melting outweighs other considerations and high pressures of blast must be used. But a sure sign of engineering is a willingness to invest in large and even expensive equipment if thereby the earnings on the investment can be increased.

Even with limited cupola capacity, the loss in melting capacity at the cupola with low pressures is often more than made up in the machine shop, by decreased cost in working up the product, as low pressures produce a soft casting easy to machine by reason of less loss of silicon and manganese by oxidation. Higher strength for the same reason is obtained under low pressures, as has been proven by government tests.

Combustion is never complete in a cupola. It requires a certain amount of oxygen to support combustion, and volume is fundamentally far more essential than pressure.

The action of the blast in the cupola is to oxidize a small portion of the carbon in the iron, and of the silicon and manganese also. Per contra, the iron absorbs some carbon from the fuel, sometimes sufficient to more than offset the loss by oxidation: not so with silicon. This is oxidized in proportion to the pressure or the intensity of the flame. A sufficiency of silicon produces soft castings by preventing the formation of combined carbon. Any increase of combined carbon increases the hardness of the castings. The oxidation of silicon and manganese is all the way from five per cent in the small cupolas to 20 per cent in the largest ones and pressure has no doubt considerable influence in affecting its quantity.

Reports received from some of our best foundrymen show what excellent results may be obtained by using low pressures of blast. These reports cover experiences with both fan and positive blowers in connection with various classes of foundry work, from castings for heavy fly wheels, engine and pump cylinders, stove work and castings, down to one-half ounce in weight. A large number of those using positive blowers are working under the lower pressures. In order to change from a high to a low pressure, of course the question of volumes must be considered and the foundryman must arrange his iron mixtures and fuel accordingly. Sometimes he must also change his manner of charging. But it will pay him to do this and melt at low pressures, unless, for instance, he is making sash weights from sheet metal scrap and old tin cans; or in case the cupola output per hour is the greatest consideration, or the castings require no machining, or their appearance is of no consideration.

With the high pressures, extra loss by oxidation of silicon and manganese is only compensated for by purchasing the grades containing higher amounts of silicon, i. e., paying more for the iron by reason of rapid melting.

The iron as it comes from the spout of the cupola is far above its melting point. No definite rule can be given for the temperature at which it should be poured to meet the different requirements of different kinds of work. However, it is recognized that in pouring for thin castings, particularly those having small cores and thin projections, hot metal run slowly into the molds is the best practice. Heavy castings having few or no cores can be poured much more rapidly and the iron need not be so hot.

It is good practice, when making a line of goods where duplication is possible, and where the daily requirements are known, to arrange for hot iron and rapid pouring. This can be done

when heats are long and practically continuous, where temperatures and fluidity can be run high. When I see the modern car wheel foundryman pouring hundreds of 700 pound car wheels per day in chills, I often ask myself, "Do the stove foundrymen really know what hot iron is?" They require at least two per cent silicon in their castings, but as you lower your rate of silicon so you can raise the temperature of pouring your metal.

Having discussed high and low blast pressures in the cupola, let me explain further by reference to tables III and IV.

For high blast pressures in cupolas we have the following capacities shown in table III:

TABLE III.

CUPOLA CAPACITIES WITH HIGH BLAST PRESSURES.

Dia. inside lining in inches.	Capacity per hour tons melted.	Pressure in ounces.
18	¼ - ½	8
23	½ - 1	10
27	1 - 2	10
32	3 - 5	12
37	5 - 6	12
42	6 - 7	12
45	7 - 9	14
48	9 - 10	14
54	10 - 12	14
60	12 - 14	16
66	14 - 18	16
72	18 - 21	16
78	21 - 24	16
84	24 - 27	17

For low blast pressures we have the following capacities shown in table IV:

TABLE IV.

CUPOLA CAPACITIES WITH LOW BLAST PRESSURES.

Cupola inside lining in inches.	Capacity for hour—tons.	Pressure in ounces.
18	¼ - ½	5 - 7
23	½ - ¾	5 - 7
30	2 - 3-½	6 - 8
35	3 - 4	7 - 8
37	4 - 5	7 - 10
42	5 - 6	7 - 10
45	6 - 7	8 - 10
48	7 - 8	8 - 10
54	8 - 9-½	9 - 10
60	10 - 12	10 - 12
66	12 - 15	10 - 12
72	16 - 18	10 - 12
78	19 - 22	12 - 14
84	21 - 24	12 - 14

I consider the pressures in table III to be the maximum allowable or permissible for the best work, and they insure the greatest melting capacity in a given sized cupola. Very few foundrymen, however, care to utilize such high pressures as shown in table III for several reasons:

First:—Because they find they can get their required capacities at the lower blast pressures by using larger cupolas.

Second:—Because the cupola lining will last longer under lower pressures.

Third:—Because oxidation of the silicon and manganese is greater under high pressures.

Fourth:—Because the resultant castings are easier to machine when made under the lower pressure.

Fifth:—Because there is less slagging under the lower pressure, owing to the fact that you do not force the cupola.

Sixth:—Because greater strength in castings is obtained in melting at the lower pressures, all other things being equal.

Seventh:—Because the horsepower required per ton melted is less at low pressures than at high pressures.

Recapitulation.

Eighteen to twenty ounces might be designated as extremely high pressures in cupolas from 54 to 74 inches inside diameter of lining, and these pressures were formerly used with coal as fuel and with small tuyere area.

Low pressure, good sand, dry molds properly rammed and vented with good facing mixtures, together with reasonably hot metal having good fluidity, will make the smoothest castings. Having a lower per cent of combined carbon makes the castings softer and easier to machine, obtained more readily under pressures indicated in table IV.

Referring to fifth reason: The liability to slag is often caused by the too rapid passing of the blast through too small tuyere openings—too high velocity, too great a pressure freezing the metal near the tuyeres and producing slag. Too small a volume of air at these high pressures will not only make much slag but cause the iron to "hang" or "bridge" in cupola. The pressures specified in table IV will not produce as much slag per ton metal, all other things being equal, that is, quality of iron, flux, etc., as the extremely high pressures indicated in table III.

Referring to the sixth reason: The present practice among foundrymen is to buy coke and pig iron by analysis, rather than by fracture, as was commonly done years ago. They now insist upon getting their iron and coke low in sulphur. However coal, (hardly ever used now), having a high percentage of sulphur, particularly when melted in connection with pig iron high in sulphur, and a large percentage of very old, long exposed, inferior scrap, together with a slow rate in melting capacity,—slower than indicated in table IV,—would produce conditions most favorable to the absorption of sulphur in the casting; but with coke and iron as now purchased, the increased absorption of sulphur would be hardly appreciable, due to the difference in melting capacities, as indicated in tables III and IV.

The sulphur bugaboo, together with the clogging up of tuyeres, has ceased to be a terror to the foundryman who knows his business.

Enlargement of Tuyeres.

While I have never seen a cupola with too much tuyere area, I have stated definitely a limit. The tuyere is necessarily cut down considerably during the heat, and unless you have surplus tuyere area to start with, you will find you are short in area during the latter part of the heat. Our modern cupolas have greater tuyere area than cupolas formerly made, but even this is frequently enlarged to meet the demands of increased melting capacities at lower blast pressures; particularly when only the lower tuyeres are utilized.

The Blast Gate.

I have found quite a number of foundry foremen who do not use the blast gate. However for the very reason that foundrymen do not generally appreciate its importance, I find it desirable to speak of it. Unless a man does use a blast gate while operating a centrifugal fan with full volume capacity for cupola, he will not be able to get exactly the same quality of iron at all periods of the heat. Even users of positive blowers are now installing regulating rheostats to control pressure and volume of air blast during the heat, where previously this matter was not considered essential.

Absorption of Sulphur by Slag.

Low blast or pressure with sufficient volume will give hot iron and good fluidity. Many will say they get good hot iron with good fluidity at pressures lower than those in table IV. On the other hand, a cast steel company operating a positive blower at 17 ounces with 72-inch inside diameter cupola, has been getting dull iron, while their two neighbors, both operating cupolas of the same size, with practically the same size and character of blowers, are doing good work at very much lower pressures. A company in South Bend, Ind., is making beautiful and intricate castings by cheap labor and using pressures at 4 to six ounces in wind box, having reduced from time to time (after a long experience), from the higher pressures. They are not troubled with any sulphur. Other foundrymen have been reducing their pressures under the advice of their foundry chemists.

However, with pig irons and coke high in sulphur, the rate of melting has considerable to do with the amount of sulphur that will be absorbed in the castings. Fast melting permits the iron to absorb but little sulphur in comparison with slow melting, under abnormally low pressures. This possibly is one of the greatest arguments for fast melting.

TABLE V.
Volume of air required per ton of iron melted.

6	lbs.	iron	to	1	lb.	coke	33,000	cu.	ft.	of	air	per	hr.	per	ton	iron	per	hr.
7	"	"	"	"	"	"	31,000	"	"	"	"	"	"	"	"	"	"	"
8	"	"	"	"	"	"	29,000	"	"	"	"	"	"	"	"	"	"	"
9	"	"	"	"	"	"	27,000	"	"	"	"	"	"	"	"	"	"	"
10	"	"	"	"	"	"	25,000	"	"	"	"	"	"	"	"	"	"	"

The average is about 30,000.

Horsepower Per Ton Melted.

If we assume the price of a horsepower is $45 per year, the 30-ton heat will cost only from $1.50 to $2. If we assume the iron to be 2¼c per pound of casting, the cost of this power is 1-1000th of one per cent of the total cost of the iron or 2¼ thousandths of a cent per pound. Of course, if greater power is used a larger motor will have to be purchased, and the added expense of installation is more than the added expense of operation. The amount of power saved by more economical melting is small for one cupola, but in the case of a certain large corporation, operating a considerable number of large cupolas for heats of six to eight hours' duration, the difference in cost of power between the high and low pressures amounts to $25,000 per year, in favor of lower pressure.

If larger cupolas with lower blast pressures are used the same capacity per hour may be obtained as with smaller cupolas, and considerable horsepower be saved in consequence thereof. I do not mean to assume that the amount of air may be indefinitely increased by enlarging the tuyeres and not increasing the pressure. This may be done to a certain extent, but we soon reach a point where the equivalent area through the charge in the cupola is less than the tuyeres. If we take for instance two 84-inch cupolas to which are to be supplied 24,000 cubic feet of air per minute at a 10-ounce pressure, we note from our table of the velocities that 216 square inches area is required for the passage of 24,000 cubic feet of air per minute. The combined tuyere area of two 84-inch cupolas is 1,264 square inches, or about six times the area required to pass the stated amount of air at a velocity due to a 10-ounce pressure. In other words, it is the resistance of the charge which regulates the amount of air which can be forced through the cupola at given pressure by any type of blower and not altogether the area of the tuyeres, when these tuyeres are of a size which will make their total area larger than that which is required to pass the requisite amount of air. Just as increase of the tuyere area in a blast furnace would not permit of a low pressure blast being used, so certain kinds of charges in cupolas require a higher blast pressure to force the air through them, regardless of any increase in tuyere area. By this I do not mean to belittle the importance of the size, arrangement and position of the tuyeres in the cupola. This is, as I have said, of great importance, but I think does not largely affect the volume when high pressure is used, particularly when obtained by means of the displacement blower.

The pressure limits the volume carried by any given pipe. In other words, a 12-inch pipe will carry a fixed volume of air at eight ounces pressure, but a larger volume at same pressure requires a larger pipe. It is therefore apparent that increased tuyere area and properly proportioned supply pipe and ample area in wind box is desirable for low pressure, when using the centrifugal fan blower. Inversely, when tuyeres are small, higher pressures are required to obtain the volume necessary, and then a blower of the displacement principle is required.

I find that the amount of air required to melt a ton of metal per hour depends principally upon the size of cupola, the ratio of coke to metal used in melting, the character of the coke, and the manner of charging. In a cupola, air is blown over the melted metal, not through it; the oxidation of carbon is slight and incidental, not fundamental and complete, as in a converter when air is blown through the metal. The volumes in Table V are approximately correct for air required per ton melted per hour:

Conclusions.

Less pressure required for coke than for coal.

More volume required for coke than for coal.

Larger tuyere area required for coke than for coal.

Coke more rapidly chilled by high velocity or pressure.

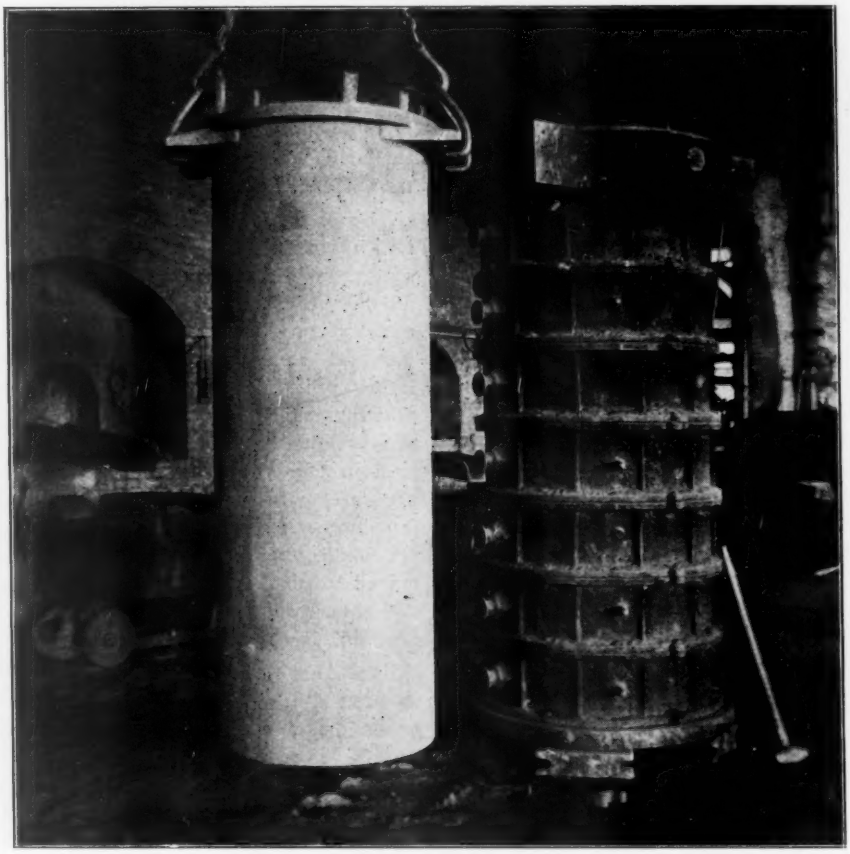
Tuyeres and lining will not burn out so quickly under the low blast pressures.

Too much air will reduce the temperature of the gases and retard combustion, particularly when introduced in top row of tuyeres.

The blast should be started at low pressure, and increased up to the maximum pressure required during the heat. The pressure should be lowered again at the end of the heat, for the reason that having less metal in cupola and more space around it, oxidation of silicon in the iron and the consequent hardening of the castings is prevented. Choked tuyeres are prevented by having large tuyere area with plenty of volume at low pressure, good iron and good fluxing.

Blast pressure is advisable, provided the cupola is large enough to give the required melting capacity, provided the blast pressure is not reduced enough to make melting unreasonably slow.

This paper would not be complete without an expression of my sincere thanks to the gentlemen who have so willingly responded to my questions concerning cupola performance.



A PERMANENT MOLD.

A PERMANENT MOLD.

BY GEORGE W. KELLY.

The writer has read THE FOUNDRY with both pleasure and profit and has gleaned many good things from it. There is, however, one branch of the

molding business that is seldom discussed and it is to this that I should like to allude. The subject referred to is the making of more than one casting in a dry sand mold. I am aware that there is nothing new under the sun, but many foundrymen do not know that a plain casting made in dry sand can be duplicated many times in the same mold. It can be done where there is a good quality of molding sand adapted to heavy work, and where good facings are used. The accompanying photograph was taken of a dry sand mold and the steam cylinder casting which was made in the same. They might be likened to mother and child and this dry sand mold is the mother of fourteen castings. The fourteenth casting is just like the previous thirteen, the surface being a beautiful sky blue color without a blemish on it, and there is every indication that the mold is good for from four to six more castings.

These cylinders are 32¾ inches outside diameter, 7 feet, 7 inches long, and the metal 1½ inches thick. The bottom end is closed with a head cast in position. The top end has a flange and two wings or supports cast on. The average weight is 3,800 pounds. The casting, as shown in the illustration, is just as it looked when lifted out of the mold. The casting is poured on end, the metal being dropped into the mold through nine square gates, as shown at the top of the casting. The first metal entering the mold falls eight feet from the bottom of the runner to the bottom of the mold, which is certainly a good test of a new mold.

In making the mold, each section or ring is rammed up separate and then stacked one upon another to the desired height. The core is made on an arbor wound with hay rope and covered with loam, and hence cannot be used but once. The pattern used in making the cylinder is a simple pulley ring pattern.

After each casting is taken out of the mold the molder's helper goes down inside and brushes off all of the old lead blacking. The molder then puts on a new coat of lead. After this the mold is put back into the oven and dried. The drying requires but a small amount of fuel, as there is nothing to dry but the blacking. We ordinarily make from ten to fifteen of these cylinders each year, and it was about eight years ago that the thought occurred to me that more than one could be cast from a single mold and our experiments along this line have been rewarded by the results described above. I would like to hear from others who have made experiments along similar lines.

OPEN-HEARTH STEEL CASTINGS.—VIII.

BY W. M. CARR.

Relation Between Composition and Physical Properties.

Silicon.—To the gray iron founder silicon conveys a different impression than to the steel founder. In one case it is regarded as a softening agent because of its property in releasing graphitic carbon in the cooling of gray iron when liquid and thus lowering the combined carbon which tends to make iron castings hard. In the other case, the carbon being low and entirely in the combined state with no graphitic carbon liberated, the function of silicon becomes a different one. To a slight extent, about one-tenth that of carbon, the effect is to harden steel castings. Primarily the purpose of adding silicon to open-hearth steel is to promote solidity, but an anomalous condition sometimes arises in unsoundness coupled with an amount of silicon in the finished product usually considered enough to produce the opposite and desired effect—soundness. In general practice 0.30 per cent is enough to give freedom from blow holes, but if unsoundness still presents itself another condition is operating which will be explained later. To greatly exceed that figure is wasteful and would tend to induce brittleness in the castings which, however, may be more or less modified by heat treatment.

Silicon in steel casting practice is depended upon mainly as a deoxidizer and the action may be understood by the following equations.

(1) Solid Solid Solid Gaseous
$$FeO + C = Fe + CO$$

As already explained the foregoing reaction always occurs in a bath of molten steel until some agent is introduced that possesses a greater affinity for the oxygen combined with iron as ferrous-oxide. Silicon being available for the purpose reacts as follows:

(2) Solid Solid Solid Solid
$$2FeO + Si = 2Fe + SiO_2$$

and under normal conditions stops the gaseous formation assisting the production of sound castings. The SiO_2 (silica) being lighter than iron floats upwards to the surface and becomes part of the slag.

If a test-spoon of liquid steel be taken from the bath when the action is most lively, the metal, as soon as it begins to solidify, will emit volumes of minute sparks giving evidence of some gas-forming action or release of some gases in conformity with equation (1). If the specimen when cold is separated by fracture, a sponge-like texture will be noticed as the result of the afore-mentioned escaping gases; and which will suggest what might be expected were such metal poured into castings without a deoxidizing or solidifying treatment. Just what the composition of the gases are is not clearly known, but it is certain that the reaction in equation (1) is largely responsible for the greater quantity of them. Some authorities anticipate the presence of such gases as hydrogen and nitrogen. Their presence may be possible in pneumatic processes, but scarcely in open-hearth steel wherein fluidity of the bath is maintained by the heat of a flame action radiated through a protective layer of slag and entirely away from the possible contamination of such gases subject to introduction with the atmospheric air necessary for flame combustion and which do not come in direct contact with the metal below the slag. Proof is ample that perfectly sound castings can be made, depending solely upon deoxidizers which possess no attraction for hydrogen or nitrogen; therefore if they should be present they are not sensibly indicated by porosity. Silicon is accredited with the additional property of increasing the power of steel to dissolve or occlude gases. The question is largely conjectural because from practical observations the evidence in support of such a theory is wanting. It is difficult to conceive of a solution of a gas in a solid without some intimation of pores; if such pores do exist they can only at best be minutely microscopic. The writer, in his experience, has not observed any condition attributable to the occlusion of either free hydrogen or nitrogen in open-hearth steel castings.

The question of the influence of silicon beyond solidity has no bearing on weldability or forgibility such properties not being considered in steel castings.

Sulphur.—Perhaps there is no element which is so strongly stigmatized as an enemy in steel casting practice. No one as yet has claimed that it is harmful in the finished casting, yet specifications usually state that it shall not exceed 0.05 per cent, and for what reason is yet not understood. The manufacturer may be more concerned in seeing the sulphur excessive rather than the customer. Whether a casting may carry 0.05 per cent or more cannot affect its value in service. Whatever harm may follow an excess of sulphur ought to manifest itself before the casting is stripped from the mold and thus prevent it reaching the customer. Authorities state that sulphur tends to make metal "red-short," a condition existing in iron and steel exhibiting itself by the metal crumbling or cracking when being worked, rolled, forged or welded at temperatures suitable for such operations. The effect is not always due to the presence of sulphur, which may be masked or modified by other constituents. In steel castings it is said to produce "red-shortness" also and which may be described as property of the metal to separate or crack at points where the contractive force

is greatest during a period when the metal is passing from a liquid to a viscous semi-plastic state. The condition may or may not occur in concordance with the amount of sulphur present, "red-shortness" may appear with a very low sulphur or it may be absent when the sulphur is considered high so that it is not possible to scan a chemical analysis and reconcile the varying degrees of "red-short" elects with them. It is possible to have castings of a given design molded repeatedly under as near as possible like conditions yet have some "red-short" and others absolutely free from any such flaw with identically the same steel in composition in each case. Similar designs may be cast in acid and basic steel separately. The acid casting may not be "red-short," but the basic badly so, or vice versa, yet in the first instance the sulphur will be nearly 0.05 per cent and in the other 0.025 per cent or less. The repetition of such evidences all tend to discredit the belief that sulphur is the main cause of castings being "red-short" in the mold. The presence of manganese exerts an effect to neutralize sulphur's "red-shortness" without changing the ultimate analysis of sulphur. An excess of the last named element beyond 0.07 per cent in steel castings may give some trouble, but generally the ranges are between 0.015 to 0.05 per cent, and within them it is practically inert. The common practice is to carry the manganese at or about 0.75 per cent and with that quantity the usual content of sulphur will exist entirely as a harmless sulphide of manganese. Were the manganese much lower the sulphur then might exist as an iron sulphide, the latter combination being more active as a "red-shortner" than the former. If "red-shortness" should persistently appear in steel castings with normal analyses another condition is active, a remedy for which is beyond any effort to change the composition to control it. The conditions under which the metal is treated in the melting and the design of the pattern or details of molding often play a more important role in producing "red-short" castings than sulphur.

Phosphorus.—This element, like carbon, is a hardening agent, but unlike it, its hardening influence is not subject to any great modification by heat treatment. An excess of the element produces the effect of "cold-shortness," the opposite of "red-shortness," a property of weakness under shock or impact; a condition of brittleness. Where castings are subjected to severe strains the phosphorus should be kept below 0.05 per cent, particularly with the higher ranges of carbon. Ordinary castings with no special requirements can carry as high as 0.08 per cent. Phosphorus can replace carbon as a hardener and when the carbon is high the phosphorus should be kept low because an excess of two or more hardeners will produce disagreeable brittleness, so to preserve toughness it is a good practice to keep all hardeners as low as possible, depending upon one element only for the necessary strengthening effect. The value of phosphorus as a strengthening agent is about 900 pounds per square inch for each 0.01 per cent.

No effect is known traceable to phosphorus upon the condition of "red-shortness."

Manganese.—This element is one of the most useful in steel casting practice and in all steel making. It works in conjunction with silicon as a deoxidizer and assists in the removal of gases in a very similar action by forming a fusible slag with the oxygen combined with the ferrous-oxide. When found in castings it is the result, usually, of an addition of ferro-manganese used at the end of the refining operation and with it will be carried in a certain amount of carbon. Roughly stated five eightieths of the manganese in excess of the residual amount of that element in the bath at the finishing period represents the quantity of carbon furnished by the ferro-manganese addition. So that as the manganese increases there would also be a gain in strength until a point is reached at or about 1.50 per cent when a disagree-

able weakness and brittleness would result. If the manganese is kept about 0.75 per cent, other elements being low, brittleness is absent, but if it be carried above that to about 1 per cent it would be necessary to carefully anneal the castings because without that they would be more or less brittle. Heat treatment however would improve them; conferring toughness, elasticity, ductility, and strength, provided other conditions were normal. In the higher ranges manganese has a peculiar and contradictory action. When a content is reached at or about 1.50 per cent the metal is hard and brittle, that condition remaining until about 7 per cent is reached; the metal then becomes both tough and hard. Between 7 and 14 per cent a peculiar alloy is obtained, known as Hadfield steel, which possesses the striking property of unusual toughness and hardness combined. If manganese is kept between 0.70 to 0.75 per cent in finished castings good results ought to follow. An excess complicates conditions, while falling below might cause blow-holes, "red-shortness" and other weaknesses in products.

STANDARD SPECIFICATIONS.

Note.—The accompanying table of standard specifications for steel castings has been sent to us by Mr. Carr with the statement that it should have been included in Section 7 of his article on steel castings.

AMERICAN STANDARD SPECIFICATIONS FOR STEEL CASTINGS.

	Hard.	Medium.	Soft.
Tensile strength, pounds per square inch	85,000	70,000	60,000
Yield point, pounds per square inch	38,250	31,500	27,000
Elongation, per cent in two inches	15	18	22
Contraction, per cent	20	25	30

HOW MIKE TOOK OFF HIS HEAT.

BY SAM TERRELL.

It happened a good many years ago, before the days of up-to-date cupolas, when the blast pipes that led to the tuyeres were made of leather, and the tuyeres were the good old-fashioned kind, long and narrow, and the fuel was coal.

Mike and I were apprentices in a country shop, that boasted at the busiest season of about four molders, and shortly before this event, the old-fashioned horse-gear was the motion for the blast, but as the firm was making a new outfit a combined boiler and engine had to be installed.

Mike, as senior apprentice, had been promoted to work on the floor, while I, as junior, looked after the boiler and engine, cleaned the castings, made the cores and tended the furnace.

My old friend Mike was a very important personage in his own eyes, and he never failed to sing his own praises. He would tell how much better cores he could make, what amount of work he could put through, how much iron he could wheel up the run, and how quick he could take off a heat. At first I was greatly impressed on hearing of his wonderful achievements, but as I learned to know him better, my respect began to wear off, until at last I dared my old friend to show me what he really could do.

So Mike proposed that we each should take off a heat, and would show me how to bring down the iron quicker and hotter than I had ever seen, and so it was agreed.

The next casting day found Mike out among the coal, picking out the largest shining pieces, and sorting over the scrap pile for the best iron —he was to have the first heat.

With the greatest possible care, the furnace was picked out, the lining daubed and the bottom faced—choice cedar kindling and maple hardwood was used—the furnace lit, and the coal placed, allowed to burn and settle before the iron was put on, so there should be no hanging up. How carefully Mike watched that fire, how he coaxed it to burn! My courage went down into my boots. I never tended my fires like that, and when the leather pipes were adjusted to the elbows leading to the tuyeres ready for the

blast, the coal was certainly "caught up" to the point of condition. I can see the satisfied face of Mike as the first hum of the fan told us the race was on.

The first few minutes passed all too quickly, and we were waiting to record the first drop of iron, but no iron came, and the minutes flew and still no iron. We were puzzled. One of the men suggested that perhaps Mike had forgotton to put the iron on. Poor Mike, how he worked that furnace. Tapping out was no name for it; he fairly pulled the front out. Still no iron. Where was it? What was it doing—the blast was on—it was clean, the iron must be melting, when all of a sudden there was a smoke, a smell of leather, then out of the tuyeres on every side, was plenty of iron, only it was running out at the wrong place. My what a mess. No more blast. The pipes were gone; the tapping hole bunged up. There was nothing to do but to drop the bottom, and in a kind of way we did. Did you ever see the shell on a kind of big ladle from dull iron? Imagine a cupola charged to the top, after that fashion.

Poor Mike. He had over-done the thing at the start, in his anxiety for a quick heat; the iron had melted before the blast was on, and had become solid on the bottom, and when the wind went on, iron melted and filled up the remaining space that was left, until it had reached the tuyeres. "And it was all over."

I shall have to leave to the imagination Mike's explanation to his Boss, and the mock sympathy of his friend. But I must confess it was a sort of quiet satisfaction to me at the time how Mike took off his heat.—[*The Obermayer Bulletin.*

MELTING LOSS.

During the winter we received an inquiry as to what the average melting loss in the foundry was, including the loss in melting, the shot lost in the molding sand, in fact, all losses between the purchase of pig iron and the castings sold. The editor of THE FOUNDRY sent out a number of letters requesting information upon this subject, and Mr. F. C. Everitt, secretary of the Associated Foundry Foremen, of Trenton, N. J., also sent out a large number. The results given in Table 1 are from the material collected by Mr. Everitt. In most cases the parties did not state whether or not the figures given represent the total loss or simply the loss in one melting. Of course the sprues and the home scrap must pass through the cupola a second time and be subjected to a second loss, so that the total loss between iron purchased and castings sold is always greater than the apparent loss for a single heat. A few of the foundries that did give a complete statement had a melting loss slightly above 8 per cent, but it will be noticed that the average of the total is slightly above 7 per cent. Some of the figures are apparently abnormally low and it is difficult to see how such results can be obtained.

It would be of great interest to receive information from other foundrymen as to how the melting loss is determined, and as to the actual melting loss on various classes of work. It would also be interesting to compare the melting loss in the air furnace with that in the cupola, and it is hoped that subscribers to THE FOUNDRY will send in information from which tables can be compiled, which will be more complete than the one given.

TABLE 1.

1	.0238	Stove plate castings.
2	.0813	Jobbing castings.
3	.0750	Electrical castings.
4	.1600	Heavy machinery castings.
5	.1220	Heavy machinery castings.
6	.0300	Stove and soil pipe castings.
7	.0860	Machinery castings.
8	.0800	Machinery castings.
9	.0435	Stove and heater castings.
10	.0520	Steam pump castings.
11	.0330	Car and R. R. supply castings.
12	.0800	Machinery castings.
13	.0500	Stove castings.
14	.0750	Fans, etc.
Average	.0708	

The Gray Iron Foundry Co., Chicago, Ill., has been incorporated with a capitalization of $10,000 by John B. Henderson, Robert L. Barry and Ralph E. Snoad.

THE PATTERN SHOP

SWEEPING CAST STEEL SLAG LADLE MOLDS.

BY H. J. MCCASLIN.

When slag ladles are of cylindrical form, as shown in the two half elevations, Fig. 1, the mold is usually formed with sweeps, the striking edges of which contain radial sections of the interior and exterior forms of the ladle to be cast. The sweeps are attached to and revolve about a perpendicular spindle with the aid of sleeves and a collar.

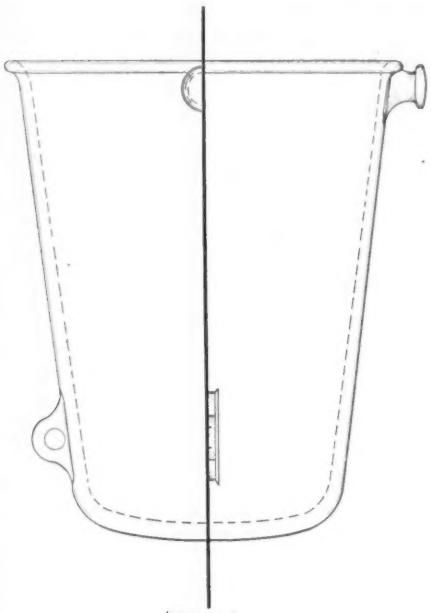


FIG. 1

At the right in the illustration is shown the half elevation of the ladle containing one of the trunions, while at the left is shown a half elevation at right angles to the other, so as to show one of the tipping lugs.

The pattern work for such a job requires the laying out of a full sized radial section of the ladle, and the making of the sweeps and fitting them to the spindle, the making of the core prints for that portion of the trunion core which extends into the cope, and the necessary core boxes for the trunions and tipping lugs.

When sweeping up molds for ladles of small diameter, say below four feet, as the one under consideration, a skeleton or built-up bottom as shown in position in Fig. 2, is usually made to form this portion of the mold. The use of such a partial pattern affords a surface for the molder to stand upon while using the sweep and finishing the mold.

After the completion of the preliminary pattern work, the molder takes the job in hand and begins operations by digging a hole in the floor to the depth of the ladle to be cast and firmly placing the spindle socket in position. The built up portion of the bottom of the ladle pattern is now placed in the bottom of hole and the spindle passed through the hole in its center and seated in its socket as shown. The spindle is then plumbed and the wall or post braces adjusted. Next, the partial pattern is leveled up and firmly bedded in place. Then with the up edge of the part pattern for a guide two surfaces are struck off diametrically opposite each other to receive the lug cores. These cores are prepared for insertion in the mold by stopping up the openings with waste or some other suitable material. They are then rammed up in position during the sweeping of the inner surface, the lugs are set back from the first sweep a distance equal to the metal thickness by the aid of a strip bradded on to the side of the sweep. The lug cores are shown in position in Fig. 2, together with the arrangement of the sweep

during the two operations of sweeping. That is, the sweeping up of the inner form upon which the core is rammed and the subsequent sweeping off of the metal thickness.

The sweep is attached to the spindle as shown and as the use of an ordinary solid sleeve causes more or less inconvenience in placing and removing sweeps, a split sleeve as shown in Fig. 3 can be used to very good advantage. The sweep is constructed as shown in Fig. 2, being provided with a detachable strip A, equal in width to the required metal thickness of the ladle. A cross section of the sweep on the line BB with the attached strip A is shown in detail at the right of Fig. 2.

After the completion of the bedding in of the part pattern and the location of the two lug cores, the sweep without the strip A is attached and the inner form of the ladle swept up, a parting being made for the cope as shown at the right of the spindle in Fig. 2. The sweep and the spindle is then removed and the opening in the part pattern through which the spindle passes stopped up with waste to prevent the sand ramming into it. With the aid of a straight edge and plumb bob the center line of the trunions is scribed across the parting of the mold at right angles to the center line of

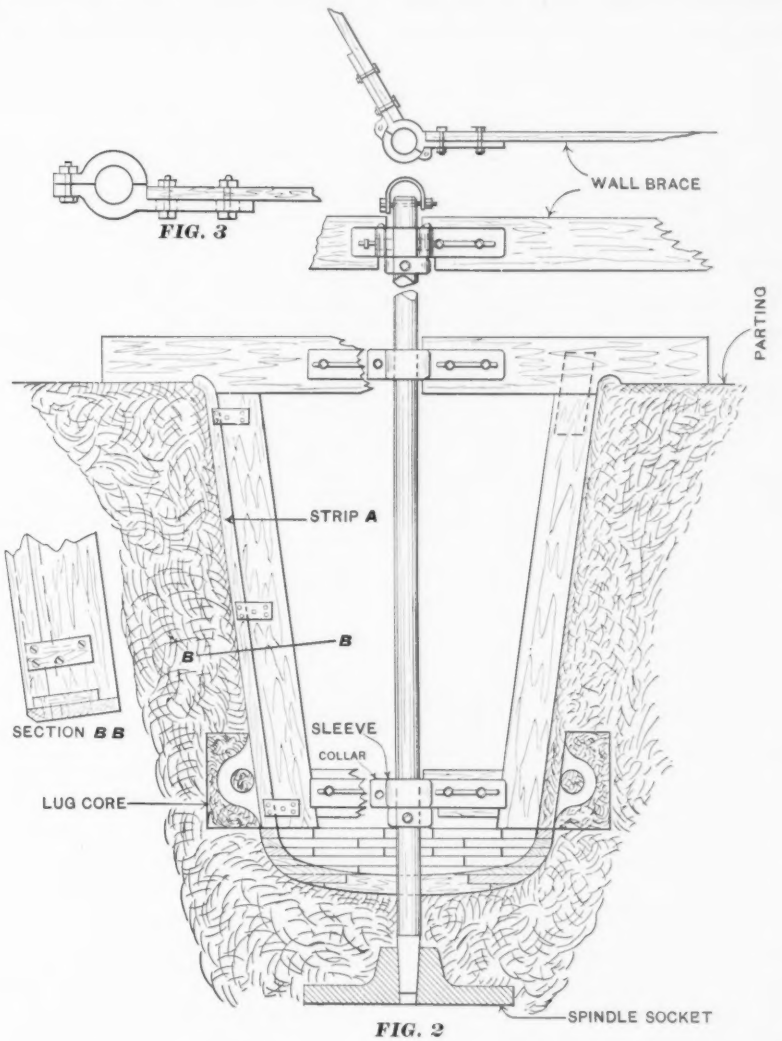


FIG. 3

FIG. 2

the tipping lugs and the two core prints are placed in position. One of these core prints is shown in greater detail in Fig. 4. These prints are set diametrically opposite each other and on a line at right angles to the center line passing through the tipping lugs. Parting sand is next applied to the parting of the mold and the interior cylindrical surface of the ladle covered with paper. A grate or crab iron conforming somewhat to the form of the bottom of the core is next placed in position and provided with bolts of such a length that they will extend up through the cope. This crab iron is shown in Fig. 5. When ramming up the core a thickness of silica sand is placed around the outer surface. Ordinary heap sand is used back of this and the interior of the core filled with coke. When the ramming of the core, with its filling of coke has reached the height of the parting line, the cope is placed on and staked in position. The core is now securely bolted to the cope. After the cope has been rammed, the cope, with the attached core, is lifted off, blocked up and finished. The outline of the two trunion core prints is marked upon the parting by scribing a line around it, after which our attention is turned to the obtaining of the proper metal thickness. The sweep surface of the interior of the mold is first roughed off with a shovel to a depth equal to the metal thickness of the ladle plus the thickness of silica facing to be used. The strip A is next attached to the sweep and the spindle returned to its proper position. The outer portion of the mold is then swept up with its silica facing, thus giving the required thickness of metal for the ladle. The depth of the trunion cores is laid off on the

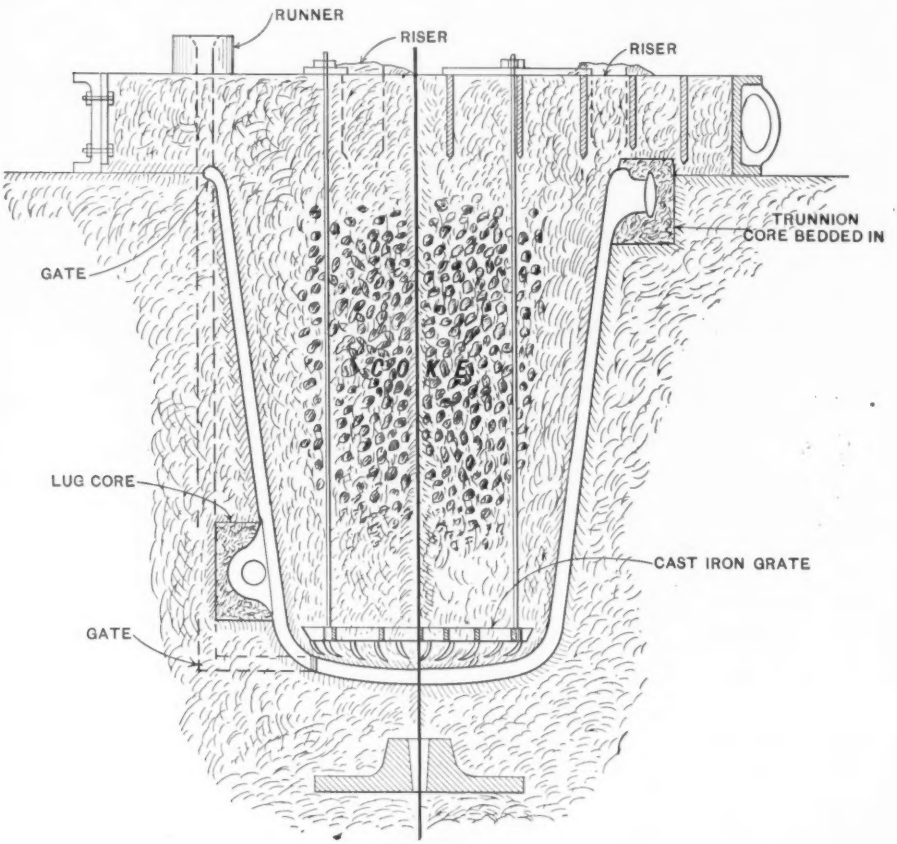


FIG. 5

sweep and transferred to the surface, after which the sweep and spindle are removed. Guided by the outline of the core prints scribed on the parting and the lines scribed on from the sweep, an opening is cut out on each side of the mold and the trunion cores bedded in in the proper position, as shown at the right in the view of the cross section of the completed mold in Fig. 5. At the left of Fig. 5 is shown a view of the cross section of the completed mold through a tipping lug, together with the arrangement of gates and runners required.

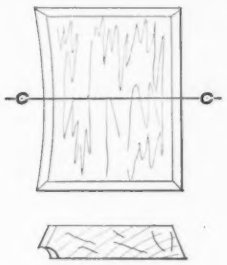


Fig. 4

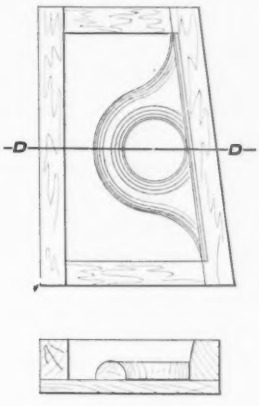


Fig. 6

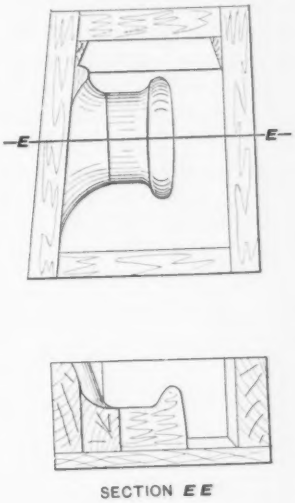


Fig. 7

After the setting of the trunion cores has been completed the side of the mold is dressed and the part pattern removed. The spindle hole is then filled up and the bottom portion of the mold slicked up and finished. This, as will readily be seen, is a rather awkward operation.

The mold is then given a silica wash and dried. The cope is subsequently placed on and tried for metal thickness and if found correct, is securely weighted down, when the mold awaits the metal. The core boxes for forming one-half of the lug and trunion cores are shown in Figs. 6 and 7. Two half boxes are required for each core.

SUGGESTIONS FOR PATTERNMAKERS.

BY H. J. MCCASLIN.

Under the above heading the writer has arranged a number of remarks and suggestions pertaining to patternmaking, which, if given careful consideration and combined with a fairly good streak of self-confidence, will go a long way toward the make-up of a thorough and proficient workman. To become a good patternmaker one must become to some extent an engineer. He must be somewhat informed upon the principles of machine design and the construction of various kinds of machinery, and he must have a thorough knowledge of molding and also a knowledge of drawing. By the latter I do not mean merely the making of drawings or lay-outs which are copies of the drawings furnished by the designer or draftsman, but an understanding of the principles of projection as applied to geometrical figures.

He must be able to read any mechanical drawing readily and form a clear idea of what the draftsman intended to convey by the drawing and he must also comprehend all of the details to the minutest degree.

To become an expert in the handling of tools, which is one of the necessary requirements of the trade, it is only

acquired by constant practice for a long time, and this practice is usually accompanied by scarred fingers.

What to Observe When Beginning Work Upon a Pattern.

Upon receiving a drawing for a pattern to be made, note the metal to be used for the casting and the number of castings to be made. The number of castings to be made will determine whether a temporary, medium or standard pattern is required and will also determine the method of construction. The construction of the pattern should be governed in such a way as to produce a casting with the smallest expenditure of time, labor and material, in both the pattern shop and the foundry. In many cases extra time spent in the pattern shop in making a better pattern will be more than saved in the foundry, or vice versa. Next, check all of the intermediate or minor dimensions to see whether they agree with the over-all dimensions. This will often save trouble later on, for in some cases the man who checks the drawing misses a dimension.

If detailed drawings of a machine or other device to be constructed are received they should be accompanied by a general drawing and this should be looked over and the general arrangements and dimensions checked.

Temporary patterns are those not likely to be used more than once. They should be made with as little expenditure of labor and material as possible to produce the required casting. Unless there is plenty of space in the pattern loft this grade of patterns should not be preserved, but taken apart and the material used up, if possible.

Medium patterns are that class of patterns likely to be used occasionally and hence more care should be taken in their construction than in the case of the class already mentioned, as they are required to withstand more hard usage in the foundry, as well as the distortion likely to occur during the storage in the pattern loft.

Standard patterns are those which are frequently used or in constant use and no pains should be spared in their construction, as they cannot be made too substantial.

Economical Use of Lumber and Supplies.

If different grades of material are provided they should be used with discretion. Knots and shaky material will not affect the inside of a box or framed up pattern. When the pattern to be made is of large size, special provision should be made for rapping and drawing it. If the pattern is too large to handle and store conveniently, it should be made in sections which are pinned and bolted together during the construction of the pattern.

The Lay Out Board.

This should only be used for such work or such sections of work as absolutely require it. For instance, in the making of web patterns or when there is a surface which can be laid out and the material then gotten out and laid down to this outline and worked to it. In such a case one lay out answers both for the determination of the dimensions and for the fitting of the stock.

Center Lines.

I wish to place proper stress upon this point in patternmaking, as it is one that is often overlooked. Prominent center lines should be scribed on all sides of the pattern and across the joint. If this is carefully observed the chances of error will be greatly reduced and the checking of the pattern facilitated. It will also improve the disposition of the pattern checker.

Contraction.

The contraction or shrinkage should be carefully considered. The shrinkage of castings is to a large extent governed by their form and the metal distribution. The presence of dry sand cores in the mold has a tendency to retard or resist the shrinkage. Hard iron or steel will shrink more than soft iron. Yellow brass will shrink more than bronze, etc. Castings of a cylindrical or box section will shrink more in length than in diameter, that is, more along the core than across it, the shrinkage in the diametrical direction or at right angles to the core being retarded or resisted by the

dry sand core. It is good practice in cases of this kind to allow one-half of the standard shrinkage for the diameter of the cylinder or across the box section.

Shrinkage for Cast Iron.

The conventional allowance for the shrinkage of cast iron is 3-32 of an inch per foot for ordinary work. When castings assume large proportions such as heavy engines or generator frames and large cylinders, the shrinkage is reduced, owing to the swelling of the mold, on account of the great pressure of the iron. Patterns for large cylinders are usually made with a 1-12-inch allowance per foot for shrinkage, while heavy engines or generator frames receive but 1-16 of an inch per foot. Heavy hammer blocks and counter weights are usually made with a standard rule, in other words, with no allowance for shrinkage.

Shrinkage of Steel Castings.

The shrinkage of steel castings is not to be relied upon as a constant. The usual allowance is 3-16 of an inch per foot, but it is subject to frightful variations. Plain straight castings will often shrink from ¼ to 5-16 of an inch per foot, while in dry sand cored molds they will not shrink more than ⅛ of an inch per foot. When, however, a contraction of only ⅛ inch is allowed, a liberal allowance should be made for finish upon all surfaces to be machined to insure the proper dimensions should the shrinkage of the castings exceed the contraction allowed. In many cases the shrinkage appears to be an ungovernable element and is apt to vary either way. As a consequence, what is usually termed "playing safe" is generally resorted to, that is, the back of the outer flange is thickened up to counteract or overcome the bad results which would result if the shrinkage should exceed that allowed, for in the latter case the flanges would finish up too thin. It is better in most cases to have the flanges a trifle over thickness than below thickness. It will also be found well to make the outlaying pads a little wider than the drawing calls for.

Tie pieces or tie bars are placed upon the castings to prevent the spreading of certain parts in cooling, or to assist the shrinkage when such parts are separated by dry sand cores. These tie bars are more applicable, and in fact, are an essential feature in the production of good steel castings, as in the latter class of castings shrinkage plays such an important part.

The introduction of these bars is really a point in molding that should be taken care of by the foundryman who is supposed to make such provisions as are necessary to produce a casting true to pattern, but provision for these pieces should be made in the core box or upon the pattern. If these precautions are not taken and the casting is delivered to the machine shop badly out of shape, the pattern shop will no doubt hear about the amount of finish it allowed.

Amount of Finish.

The finish to allow is oftentimes a troublesome problem for the patternmaker. The amount that will satisfy one machinist will not satisfy another. The proper amount of finish depends to a great extent upon the size of the piece to be machined, the method of casting, and whether or not it is turned out like the pattern. It is advisable to make this allowance as small as possible, but at the same time to leave sufficient material for the proper finishing of the casting. As a rule, iron castings which are produced in loam molds and castings made from steel are apt to vary from the proper dimensions more than those molded by other methods.

Steel castings or loam molded iron castings should receive an allowance of from ¼ to ½ inch for finish and this should be sufficient for ordinary sized work. For the general run of green sand castings from ⅛ to ¼ inch should be an ample allowance. For small brass and machine molded iron castings which are of sound metal 1-16 of an inch should answer.

Tool Clearance.

The patternmaker should consider the method in which the casting is to be finished or machined and then see that the proper tool clearance is allowed wherever it is required, as for instance, at the ends of all surfaces to be planed

or milled. A little thought expended on this point will save many hours of chipping in the machine shop. Some unscrupulous fellow will say, "Oh, that's none of my business. They should look after the machining of the castings." This is not the proper spirit for the patternmaker to exhibit, as he should have an interest in the casting clear through to the final erection of the machine.

Construction of Patterns and Core Boxes.

Having discussed some of the allowance and provisions for the molding and machining of castings, let us proceed with the pattern and core box work, taking up a number of points which will facilitate this work and economize material. These points will also serve to save time in the foundry.

Machines are placed in the pattern shop to do the work and hence the patternmaker should see that the machines do the work and thus save his own strength and labor.

Glue is an indispensable material in pattern construction, but it should be applied with judgment, as there is a time to use glue and a time to let it alone. Many a badly warped pattern can be traced to the manner of gluing up the stock. Cross gluing should be avoided wherever possible, for if any shrinking or swelling takes place in such a case a distorted or twisted pattern will surely result. Unnecessary gluing often causes no end of trouble and expense when an alteration or change is to be made upon a pattern. Screws may appear more expensive than a few nails or a few spots of glue, but it is not always so, and their use should be encouraged.

Core Prints.

This is one of the knotty problems for the patternmaker to solve, but we will not attempt to settle it this time. The length or width of a core print that will answer one molder to a nicety will not suit another at all. The writer, however, believes in a good liberal allowance for all core prints, despite the fact that patterns often come back from the foundry with a portion of the core print missing, it having been sawed off by the foundry carpenter so that the pattern could be used in a certain flask. Of course the length of any core print should be governed by the size or the diameter of the core to be set. When constructing core prints of irregular form, care should be taken and provision made so that their outline can be readily transferred to a core box, that is, such core prints should be built upon certain properly determined lines and these lines noted on the layout. This method of working will avoid the use of templets and other troublesome devices which are often employed when such precautions are not taken. A core print and core should be so marked and so constructed that there is no chance of placing it in the mold in any position except that in which it is intended to go. This point is often overlooked by the patternmaker and rarely detected by the molder unless the difference is quite noticeable.

Loose Pieces.

Loose pieces on patterns, although objectionable, cannot always be avoided and in many cases would be found more economical and less objectionable than a core. When it becomes necessary to choose between the two methods of using a loose piece or a core it will generally be found better to use the former, because it will insure a truer casting and avoid the scare caused by the introduction of a dry sand core. If loose pieces or core prints are attached by two dowel pins of different diameters, the error, often caused by the molders or coremakers attaching pieces in the wrong position, will be avoided. All loose pieces or core prints should be marked or numbered plainly so that their respective positions can be determined at a glance. It is also good practice to scribe a good, heavy line around them. This only takes a moment, but it will often save the molder or coremaker many a minute's search for the location of a detached loose piece.

The length and diameter of the core should also be marked upon the core print when standard sizes are used, as the molder rarely has a pair of calipers

always at hand, as is the case with the patternmaker.

In the case of circular work when cores are used around the interior or outer diameter of a large pattern the patternmaker should mark the number of cores required to complete the circle upon the pattern and upon the core box. This will show the coremaker instantly the required number of cores to be made and save him the time and trouble of stepping the distance off around the pattern. When a special core is to be used and the core print does not distinguish it from the regular standard foundry core the core print should be marked "special core." This will often save the necessity of replacing the casting.

When making gear patterns it is well to get out several extra teeth, bore a small hole through them and attach them to the pattern. This will often save the pattern from mutilation by having several teeth ripped off by the molder should the pattern fail to draw properly.

Another method of saving the pattern from abuse is to get out a block five by three inches by two inches thick, with one side cut to conform to the inner diameter of the rim of a gear pattern. The molder is supposed to place this block against the inside of the rim and then rap upon it with a hammer. Of course this rapping is done after the cope has been lifted off. By this device the pattern can be well rapped without injuring it.

In looking up gears in the pattern loft it will often be found convenient to have the patterns marked on each side of the rim with the pitch diameter, circular pitch, width of face and number of teeth.

Old Patterns.

These should always be treated with suspicion, as they are not to be trusted, and have proven the pitfall of many a good workman. Previous alterations are not always noted on the drawing and distortions are very apt to occur during storage. For these reasons an old pattern should be checked over thoroughly when making new additions. Alter old patterns cheerfully, for though it is not a clean and agreeable job, some of us must do it, so do it graciously, but we will not blame you for kicking if you get more than your share.

Core Boxes.

Whenever the circumstances permit core boxes should be constructed of rectangular form and filled in with the necessary material to produce the required form of core. This manner of construction of core boxes will be found advantageous and convenient in many respects, and it will also save material, for when a good rigid frame is constructed to begin with it can be filled in with material almost of a temporary character, for such material cannot get out of place when supported by the frame. This construction also saves the box from the punishment it receives by rapping, for all that is required when the box has been rammed up is to remove the screws from the opposite corners of the frame and draw the frame away. The handling and the clamping of the box to the core plate is also facilitated by its rectangular form. The material which forms the core box proper should be fitted loosely in the frame, as it will have a tendency to swell and tighten itself up.

Keep the length and width of your core box scant, as the core would be liable to swell.

Bottom boards for core boxes should be made only when the form of the core requires it. The construction of bottom boards is usually only a waste of time and material and they are often thrown aside by the coremaker, for they cause him an unnecessary roll over if used, where by the use of the core plate the core is rolled over on to the plate, the box removed and the cores sent direct to the oven.

These suggestions are only a drop in the bucket in comparison to the number of little big things that serve to make up successful patternmaking and that present themselves day after day to every workman.

By all means think for yourselves, think twice before you do it, and then do not do it until you know why you are doing it.

A FEW REMARKS RELATING TO THE CONNECTION OF THE PATTERN SHOP WITH THE FOUNDRY.

It seems to me there is a wrong construction put on the relation of the pattern shop with the foundry. There is too often a mistaken idea in the general estimate of the average foundry employes, as to the value of the pattern shop. Usually it occupies a somewhat subordinate position to those employed on the foundry molding floor. Now let it be distinctly understood that the pattern shop contains the practical brains of the establishment. The patterns are the means toward the end, and it is not the man who pours the metal into the mold. Too often and very frequently the foundry foreman or superintendent has a narrow knowledge of what is required, and he is also frequently depending for practical information on the patternmaker. It is high time that the proper position of the pattern shop was acknowledged and the patternmaker, instead of filling a secondary or subordinate position, should hold his proper place in the various departments of the foundry, and that is the first place.

It is true that many of the advanced establishments recognize the patternmaker as head and brains and act accordingly, and the molding floor as a second, as it should, but there are yet too many jogging along in the old rut. It is time for the patternmaker to assert himself and to receive that respect and consideration from all departments and from the firm which rightly belongs to him. It would be to the decided advantage of employers if they seriously considered the advantage of putting the saddle on the right kind of shoulders by elevating the intelligent patternmaker to a high position of trust and responsibility. He certainly, as a thinking, practical man is better adapted for a position as superintendent than the average molder, who, when a high position is open, usually gets it thrust upon him. Perhaps it may be said that the patternmaker does not know about molding and how this work should be done, but here let me say that if the work performed in the average foundry was depending for practical information from the molding department it would soon go down. As a fact, the patternmaker has a far superior knowledge of the work and its requirements than the molder. He is more intelligent. He has to be. His occupation calls for such,—and too often the difficulties of the molding floor have to be overcome in the pattern shop. Progress in the foundry seldom comes from the molding floor, but usually from the pattern shop. Suggestions may occasionally come from other departments, but usually they are crude and the pattern shop has to put them into practical form and use. He far too often has to correct the mistakes of the drafting room and frequently prevents much loss to the employer. What does he receive for all this? Not even thanks. He receives his week's pay and usually that is all, while he sees men of far less practical ability raised to responsible and high-paid positions, men who too often have taken the credit of doing what they have received from the patternmaker.

I say, put the patternmaker where he belongs, which is at the head, and very soon the employer will learn that there is a saving and economy all round.

In conclusion, let us patternmakers work toward the end that we may occupy that plane which as intelligent brain workers as well as hand workers we are entitled to occupy in the various establishments where we are employed.

Respectfully,

A PATTERNMAKER.

PATTERN SHOP MACHINERY CATALOGS WANTED.

We have received a request from the firm of Ph. Bonvillain & E. Ronceray, 9 and 11 Rue des Envierges, 17 and 19 Villa Faucheur, Paris, France, stating that they would like to receive catalogs of modern patternmaking machinery, together with prices of such equipment. This firm now handles an extensive line of molding machines and would like to be in a position to furnish complete pattern shop equipment.

A CLUB FOR APPRENTICES.

The Commonwealth Steel Co., of St. Louis, Mo., has recently organized at its works at Granite City, Ill., a Fellowship Club among the apprentice boys. The object of the club is educational, with a view of bringing out the best that there is in the boys and enabling them to advance as rapidly as possible. In this connection the club would be very glad indeed to receive catalogs of new or standard foundry supplies and equipment, or anything that would be of interest to a young man making a study of foundry practice. If manufacturers will place the club on their mailing lists, and address such material as they may bring out from time to time to the Fellowship Club, Commonwealth Steel Co., Granite City, Ill., it will be a great accommodation to the members of the club and to the company. Many of these boys will undoubtedly develop into men capable of holding positions of trust and thus have the placing of orders for equipment in the future. We believe that such clubs, rightly conducted, can result in great good to the young men of any works.

DISCUSSION ON PAPER BY R. MOLDENKE—COKE TESTS OF U. S. GOVERNMENT.*

In the discussion on my paper considerable interest was manifested on the point relating to the actual burning up of the iron in some of the heats run during the government coke tests. At the time I stated that the very first heat made burned up half of the iron charged, this oxidizing and going into the slag. Some doubt was also expressed as to the ability on the part of the iron to do this. Mr. Shed, afterwards, in reading his paper on "Fluxes in the Cupola," confirmed my experience.

While in St. Louis a few weeks ago, to start off the second series of government coke tests, I had the wind box of the cupola that made this bad heat cleaned out, and found in it, close to the slag spout, some of the very slag which foamed through the tuyeres, and caused us to drop bottom only to find no more iron there to melt. This slag was black and heavy, and on being analyzed in the government laboratory at the fuel testing plant, gave the following for iron and silica.

Analysis No. 3402.

Silica	30.33 per cent.
Iron	43.50 per cent.

which would seem to show that the iron was going "back to nature" again.

Foundrymen have often noticed that with improper charging and running conditions, generally accidental, that their iron would disappear, and the slag formed in melting foam up even out of the charging door. This is simply a Bessemerizing the cupola, and shows how liable this melting process is to oxidation effects.

I am glad to be able to give the above analysis, as I know it will interest foundryman and metallurgist alike.

RICHARD MOLDENKE.

*From the transactions of the A. F. A. meeting at Cleveland, June, 1906.

The Independent Pneumatic Tool Co., of Chicago, has been obliged to secure larger quarters for both its Pittsburg and New York offices, to accommodate its increasing business. The Pittsburg office is now located in the Farmers National Bank building and the New York office on the sixteenth floor of the Broadway-Maiden Lane building, 170 Broadway.

BRASS FOUNDING

THIS DEPARTMENT IS DEVOTED TO THE TREATMENT OF ALL ALLOYS INCLUDING THEIR

FOUNDING, GRINDING, POLISHING, ELECTROPLATING ETC.

PRACTICAL ALLOYING, X.

BY JOHN F. BUCHANAN.

Gates and Risers for Alloys.

The gating of castings reflects the individuality of the tradesman more than any other single operation connected with the art of molding. Why? —Because the gate is the only part of the mold which is made independently. Except in the case of machine made, or repetition molds, no indication of the duty or design of the gates necessary to run the castings ever appears on the pattern. The molder must think this out for himself and as often as he gets a new pattern to work from, the problem of gates and risers presents itself. In the production of castings the making of the mold is not everything,—the gating of it is not less important than the ramming or the venting or the binding. Every different

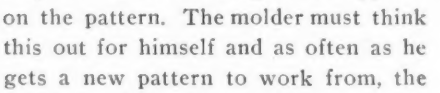


Fig. 1

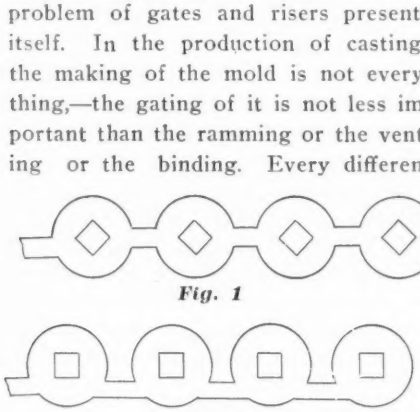


Fig. 2

class of work requires separate consideration. In ornamental castings the gate must not interfere with the design; for light castings it must be cut to fill the mold uniformly; for heavy castings it should be constructed to avoid wear or scabbing and to feed the parts solidifying last.

Again, the gate which would be ample and successful for a casting in cast iron would many times bring disappointment if used on a similar casting in gun metal and would certainly fail with cast steel. Whatever metal may be used the fluid characteristics of the metal and its behavior on solidifying want careful study in order to avoid undue shrinkage, draws, cold shuts, scabs, scale, etc. With alloys this is especially true. They are fickle compounds, and more sensitive to variations of temperature and conditions than the homely cast iron. The primary object of a gate is to fill the

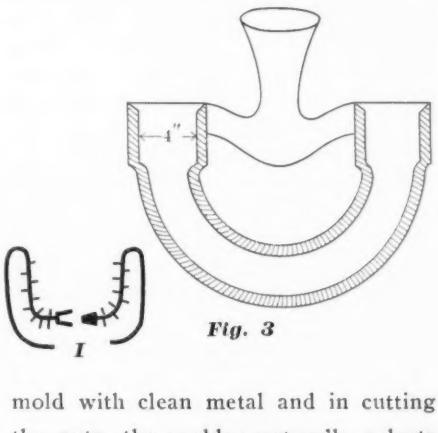


Fig. 3

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mold with clean metal and in cutting the gate, the molder naturally selects the line of least resistance for the flow of the metal, unless some other consideration, as machining, or avoiding the use of chaplets, is taken into account. Fig. I is a simple illustration of how not to gate a casting. Here we have a spray of washers with square holes. The gates are so led that the metal in passing through the mold, must wear away the sharp corners and the castings will contain minute specks of sand making them unsightly and difficult to polish. Fig. II shows the remedy for this. Fig. III is a section of a four-inch brazing metal bend for distillery coils. These castings are only five thirty-seconds of an inch thick.

They are made from a shell pattern with green sand core. The core iron, made of 5/8-inch square iron, comes in two halves as shown at I. No chaplets or nails are used; the core iron is rigid when closed and the legs are long enough to balance the core. A

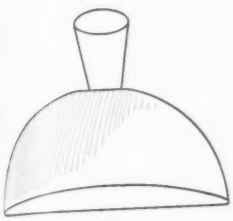


Fig. 5

Fig. 4

pressure of 36 pounds per square inch is applied to the castings and the best results follow from the method of gating shown. Fig. IV is another example of a light casting—a cover for an electric drill motor. The gate shown is for yellow brass, but sometimes these are cast in aluminum, when a different method is adopted—Fig. V. This illustrates the fact that gates should vary with the metals used as well as with the forms of the castings made. The disposition and dimensions

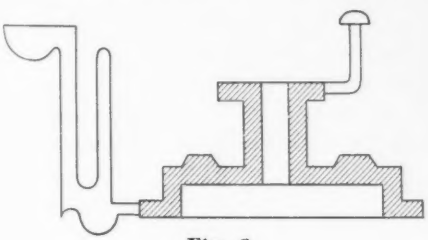


Fig. 6

of gates and risers is not a subject about which one may dogmatize or lay down hard and fast rules. Similar castings may be successfully run by different gates. Take the blank gear wheel, Figs. IX and X. Five different gates are shown, any one of which may be adopted with success if attention is given to the casting temperature (gun metal is meant) and the condition of the mold. The question of machining often decides the method of pouring. A casting which has to be machined all over is generally cast vertically, or with the smallest area to the top. Fig. IX fulfills the latter condition better than any of the styles seen at Fig. X, but it is open to objection on account of the gate being placed on the most

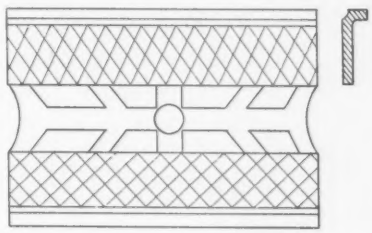


Fig. 8

critical part of the casting,—that is where the teeth are to be cut. The easiest way to make a mold is not always the best for the casting; much depends on where the important parts are located. Usually particular parts or machined surfaces are made to form the under side of the casting as the

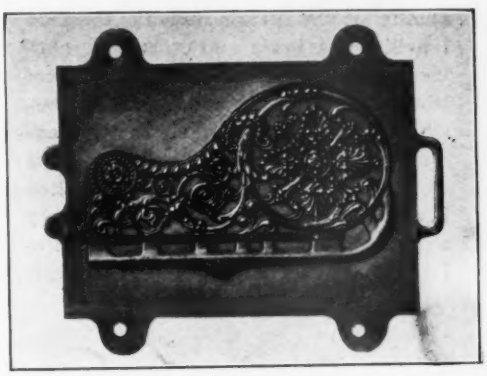


FIG. 7.

top side, in horizontal pouring, is always weakest. Fig. XI shows the general practice in marine brass foundries in casting valve seats. The mold is made with the flange uppermost and when it is finished it is turned over and what was the drag in molding becomes the cope in casting. The tiniest speck on the face of this casting would condemn it. Engine brasses supply another example of the same practice.

Fig. XII illustrates one style of gate and Fig. XIII is an alternative gate used with such as are molded in three-part flasks. The whole of the gate (Fig. XIII) is cut in the cope, except the small leaders represented by dotted lines at Fig. XII.

From the Author's Article in The Foundry, December, 1903.

"Casting brass on to iron or steel is always a difficult matter to accomplish satisfactorily. The expansion of the metals is different, causing cracks; the affinity of the metals is weak, the iron repelling the brass and creating sponginess; besides it is well known that iron when it is heated, emits a gas, which in the case of shaft liners accumulates inside the mold when it is closed and is absorbed by the molten brass when it is poured, producing troublesome blow holes. The remedies for these evils are first: not to overheat the iron—a very dull red scarcely perceptible in the shade being all that is required; second, to provide sufficient risers for carrying off the gases and feeding the casting. Pump rods, feed screws, eccentrics and other small gear, are usually lined in vertically cast molds, but with tail shafts running 12 feet and upwards in length and weighing several tons, this method is impossible. Horizontal pouring may be quite as successful if the precautions already indicated are taken. From Fig. 14 it will be seen that a bed plate is leveled to receive the shaft which is supported by iron stools having V-shaped notches on the top. Strips of wood the required thickness of the liners are then tied around the circumference to form the patterns and the molds are rammed up with the shafts in position, the parting being formed at the center. The copes are then removed and the shaft lifted out and placed on supports ready for heating. Great care is necessary in this part of the work as the shaft is liable to warp if it is not properly blocked up."

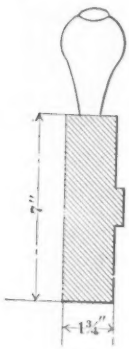


Fig. 9

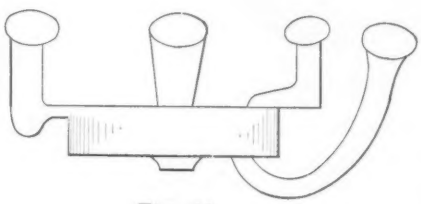


Fig. 10

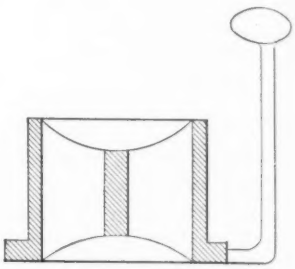


Fig. 11

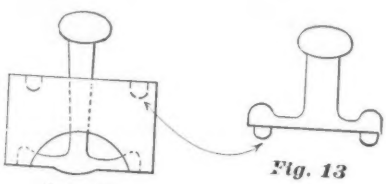


Fig. 12

Fig. 13

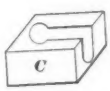


Fig. 16

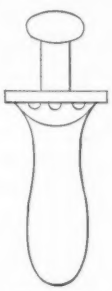


Fig. 18

The number of risers strikes the average molder as being abnormal, but these are exceptional castings and if an open continuous riser could be arranged for, instead of a series at short

intervals, the results would be even better. Risers are chiefly used: (a), to relieve the pressure on the mold; (b), to prevent gas cushions; (c), to collect dirt; (d), to keep open communication with the mold as a tell-tale during the cast, and (e), to feed heavy internal sections.

Risers are never used on large bells because the metal, to ring well, should be as dense as possible; this object can only be attained by giving the sounding rim all the pressure available.

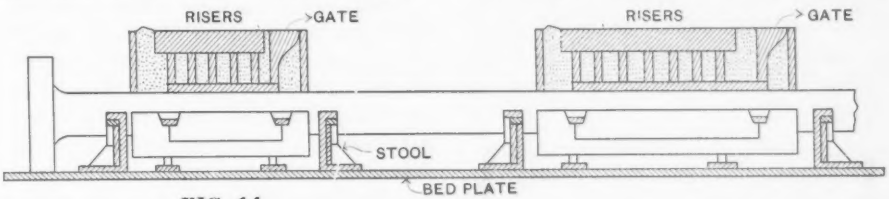


FIG. 14

To prevent sullage or dirt entering the mold, what is termed a "plug head" is used. A dry sand runner basin is made up on top of the mold and a plug made to fit the down gate by casting a section from the gate pin in plaster of Paris and inserting a hooked iron therein before the mixture sets. This plug is fixed in the gate, while the head is filled with metal. It is then lifted out by using a rod of iron as a lever and the ladle keeps a constant level of metal in the head until the mold is filled up. The plug head is largely used for statuary and heavy ornamental castings.

Other forms of gates devised to admit only clean metal to the mold are skimming gates (Fig. VI) and core gates Figs. XVI and XVII. We have seen then, that the gate varies with the style of casting and with the nature of the metal. For thin, light yellow brass castings as stair treads, Fig. VIII, the gates should be shallow and wide, with a heavy down runner to make it easy to fill the mold quickly. Another fine example in this class, but of a more ornamental nature, is seen at Fig. VII. This is the reproduction of a casting as made by the National Cash Register Co. Such castings require skill in pouring the metal; indeed in foundries where much light work is made the pouring is done by a class of men called "'casters." These men are expert in filling such molds and wasters due to irregularities in pouring are reduced to a minimum. It may be mentioned here that we have intentionally avoided any reference to the fixing of gates on machine made molds. That is a special branch of the subject which would be better dealt with by an expert in machine molding. Great ingenuity is often displayed in arranging the patterns for an oddside, or for spray work in "plate" molding or machine molding. The main object is to press as many pieces as possible within the area of the flask, in positions that will give good clean castings, with gates which

FIG. 15.

will be economical of metal in casting and also of labor in cleaning. A few pointers on gating follow: 1st. The flow of metal should not meet with any obstruction on entering the mold.

2nd. As a rule the mold should be gated at a heavy part. 3rd. The smallest sprue which will run the casting satisfactorily is the best for getting over faults in pouring. 4th. The drop gate is very useful for thin castings of large area as well as for heavy castings with variable thicknesses. 5th. In some cases a cleaner and sounder casting can be obtained when the metal enters at or near the bottom. 6th. Round gate pins give the best results generally. 7th. Spray gates should make a short connection with the leader and they should always be deeper and wider there than at the mold cavity. 8th. The pouring basin or

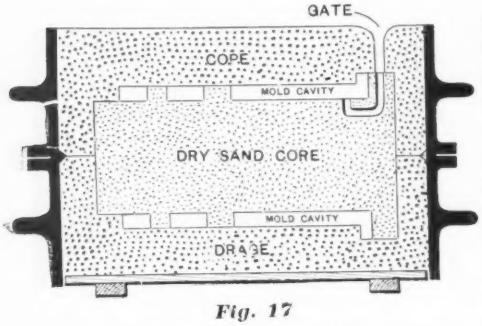


Fig. 17

head should be so constructed that it can be kept full, otherwise the dirt which collects on the surface of the metal will be washed into the mold and result in a defective casting. 9th. Core gates are useful when it is desirable to fill the mold with a gentle stream from the interior. 10th. In intricate castings the gates must be distributed to ensure that the metal shall reach the vital parts in good condition; at the same time care must be taken to avoid scabs from the metals impinging upon weak internal parts. 11th. In gating phosphor bronze castings, molded in green sand, make a practice of feeding the heavier parts through the nearest lighter section. 12th. Don't experiment with a new gate if the one regularly in use gives satisfaction, unless it is to economize metal or facilitate molding.

Heavy castings call for good judgment to decide upon the size and number of gates required. In making up the head for a large mold the runner basin should be central, if possible, so as to give an equal distribution of the metal to the gates. Making up the head is a part of the work which is apt to be hurriedly done since it is the last duty in preparing the mold for casting. Carlessness in this part of the work will spoil the casting just as readily as bad molding. The gates illustrated here are only a few selected for their interest to general brass founders.

Firms adopting a specialty soon find out the most practical means of gating the castings they make. For example, screw propeller blades for ships are recommended to be cast in manganese or aluminum bronze. It was found that the horizontal method of pouring such castings in gun metal gave unsatisfactory results with the alloys mentioned. Now, propeller blades in manganese and other bronzes are invariably cast in the vertical position (Fig. XVIII). This is an ideal style of casting for pouring on end because it is self-feeding and in cooling out it sets from the bottom upwards. Nevertheless, horizontal pouring is necessary when gun metal is used. The liquation of the tin in heavy masses of gun metal, would produce a casting with brittle edges and irregular composition in the thicker parts of the blade if it was cast vertically.

BRASS FOUNDRY NOTES

BY C. VICKERS

SPONGY SPOTS IN CASTINGS.

Inquiry.—We are having considerable trouble with spongy castings, also sand holes. We make a line of plumbers' brasswork, mostly yellow brass for nickel plating. The castings usually show up all right until they are buffed, when sponginess develops. In our mixture we have been using scrap copper wire and some copper bottoms. We use New Albany, Ind., molding sand. Can you tell us what the cause of the trouble is and give us a remedy for the same?

Answer.—There are three great causes of spongy brass castings. Namely, unskilled melting, unskilled molding and careless casting. The first named cause is the greatest. In this instance the brass is made from wire and copper bottoms, things that require exceptional care in melting to avoid oxidation, and consequent absorption of gases in the metal. As I have already touched on this subject in a recent issue, it will not be necessary to go into the matter as fully as I did then. I wish, however, to emphasize a few points I made then. These are, first, the use of charcoal. Always see that it is used in melting scrap copper.

Secondly, never allow wire, copper bottoms, etc., to melt down in the crucible of its own sweet will, but *push it down.* See that it is under the layer of charcoal. Do this as soon as it becomes red hot, as it is then soft and tractable, or punchable. Afterwards charge more scrap, and as soon as red, punch it down, and repeat the operation until the charge of copper is melted. The charcoal should have been added from time to time as required and the melted copper will now be under a cover of charcoal.

Caution. Do not use aluminum in your brass.

The second cause of spongy castings covers such things as "hard ramming," "wet sand," unsuitable gates, and dirty molds, which produce sand-holed castings and the remedy is apparent.

The third cause, careless casting, might be added to the burden of the unskilled molder. If the metal is poured too hot it will produce "pin-holes." All these troubles are easily corrected by a skilled man in person, but difficult to explain on paper.

A STEEL FOUNDRY LABORATORY.

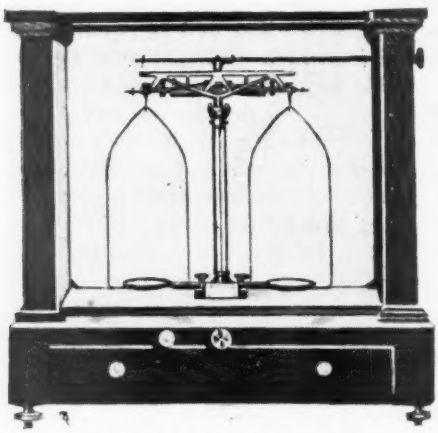
BY ARTHUR SIMONSON.

One of the essentials to success in the operation of a steel foundry is a well equipped laboratory, where the analysis of all the raw materials entering into the manufacture, and also that of the finished product for checking purposes, can be made. Having been asked for a description of a laboratory of this kind the following article is written with the object of supplying the necessary information. Nowadays when buying pig iron, coke, etc., it is customary to specify the analysis wanted, and most producers are willing to guarantee their materials within certain limits, supplying with each carload an analysis of that particular lot. At all events it is supposed to be the analysis of that particular carload, but is more often the analysis of the cast or pile from which the car was loaded. As any cast of pig iron necessarily varies from one end to the other, it is wise to take a sample from each car and check the composition before using, to avoid mistakes.

Steel is manufactured today on such close specifications and is required to be of such high quality, that it is impossible to get along without a laboratory, and the chemist is often the means of saving money to his employer by not only avoiding mistakes, but by locating trouble when it occurs without loss of time. The laboratory should be located where a north light is available and in some part of the works where the vibration caused by operation of heavy machinery, cranes, steam hammers, etc., will be felt as little as possible, for a great deal of the usefulness of the laboratory consists in the weighing of materials with exceeding accuracy, and the balance used is sensitive in the last degree. There should be two rooms, one not less than eighteen feet square, and the other may be smaller, for the balance and the chemist's office. Around three sides of the larger room should run benches about twenty inches wide and the other side is left for the draught closet, muffle furnace and sink. The laboratory proper should be sheathed entirely in wood, as plaster is affected by the fumes and will fall into beakers, etc., with the result of spoiling estimations. There should, if possible, be a passage between the two rooms in order that through the protection of two doors the balance may be pre-

served from the action of acid fumes. Under the benches should be drawers for apparatus that is not in constant use, filter papers, etc., and these drawers should be well fitted to exclude dust. It is very important that extreme cleanliness should be observed in all directions. The bench or table supporting the balance should be very heavy and rigid, to minimize vibrations, as it is entirely impossible to weigh quickly or accurately on a balance that is not perfectly steady. An extra case of wood should be placed over the balance to further exclude dust.

Around the walls of the laboratory should be shelves at a convenient height above the benches, to hold the bottles containing reagents for im-

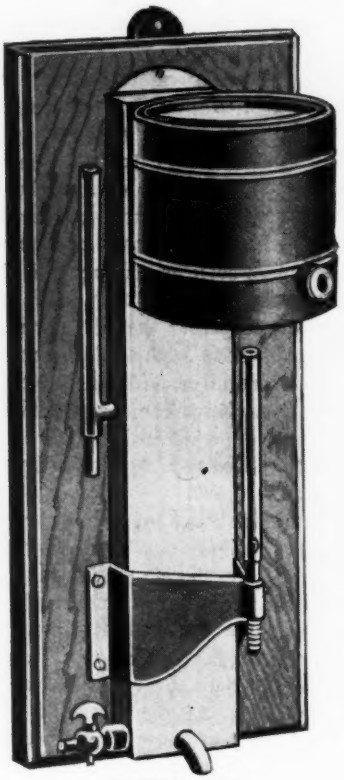


SHORT BEAM BALANCE.

mediate use, and underneath the benches the large Winchester bottles of acids may conveniently be stored.

The following is a description of the principal apparatus needed for analysis of iron and steel materials, coke, sand, firebrick, etc., and while more may be provided, or special apparatus used in some cases, the ordinary work of a steel works laboratory may be done with what is appended below.

Balance. This should be of the best quality, as it lasts practically forever and is responsible for the accuracy of results. It should have a short beam, not over seven inches long, which should be of non-corrosive material, the longer beam balances make the time of weighing very much longer as they take so long to oscillate. A seven-inch beam will be sensitive to a tenth of a milligram, which is sufficient for all practical purposes. All knife edges and planes should be of agate as the steel knife edges will rust in spite of all care that may be taken to prevent it. In the balance case should be one or more small vessels containing strong sulphuric acid or chloride of lime to absorb the moisture in the balance case, and these should be changed from time to time. A small

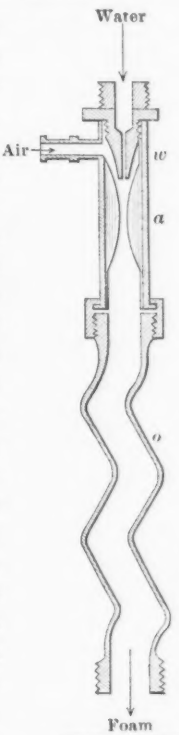


A HANDY STILL.

camel's hair brush should be used daily to dust off the balance. A set of weights is needed running from fifty grams to one milligram, and riders to hang on the graduated beam of the balance for subdivisions of one milligram. The pans of the balance should be large so as to accommodate small pieces of apparatus that may have to be weighed from time to time, but the metal pans should never be used for

the actual weighing of materials, instead a small aluminum pan, counterpoised by a small weight should be used. It cannot be too strongly impressed that the balance must be scrupulously clean and in good condition, as this is where all accuracy will be destroyed at the outset.

Distilling apparatus. Some form of still is necessary, as pure water must be used in all determinations. There are many forms of still, and a simple and effective one may be made by connecting a live steam pipe, if a steam line is handy, to a coil which can be kept cold by a stream of water from the laboratory service pipe. This is the cheapest way of obtaining a copious supply of pure water. If a steam pipe is not available, a self contained still must be provided, and one having a capacity of twenty or twenty-five gallons per day will be large enough.

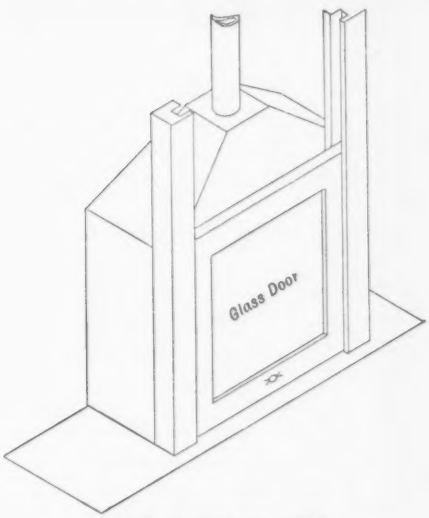


FILTER PUMP.

Filter pump. For heavy or gelatinous precipitates, it is necessary to have a filter pump to reduce the time of filtering. This consists simply of a specially shaped pipe, having a side inlet, attached to the water supply, and the water passing through the vertical pipe causes a powerful suction through the side pipe. This is connected to a filter flask, which is a conical flask having a side tube and a rubber cork fitted with a glass filter funnel. When filtering by means of the pump it is well to introduce a platinum cone perforated with small holes, to prevent the suction from bursting the filter paper.

Muffle furnace. This is for incinerating precipitates, fusing refractory material, etc., and should be large enough to contain a muffle about eight inches by five. It is heated by a row of five or six bunsen burners in a battery, which may be controlled independently so as to heat different parts of the furnace to different temperatures if desired.

Draught closet. This is an enclosure containing an iron plate with burners beneath, and is used for evaporations, solutions, and for the making of any reactions which give off fumes or gases which would be unpleasant

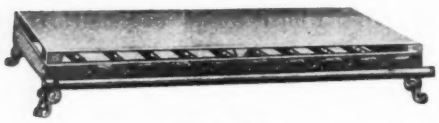


DRAFT CLOSET OR HOOD.

or dangerous. It should have a chimney with a good draught which may be increased by the introduction of a jet of compressed air blowing up the chimney. Practically all boiling of liquids is done in this closet although there are gas connections at intervals all round the benches. The laboratory is in this way kept cooler and more pleasant to work in. The plate should not be less than 24 inches long and 16 inches wide as at times a great many beakers will be evaporating at the same time. The glass door slides in grooves and is counterbalanced by sash weights. The inside of the draught closet is preferably lined with tiles.

Carbon bath. This is a piece of apparatus used for the determination of

carbon by the color method and consists of a copper vessel about seven inches in diameter and seven inches high. It contains a support for the test tubes to be heated, in the form of two perforated discs held together with a wire support. The test tubes are introduced into the holes and are by this means held in a vertical position while boiling, and prevented from being broken by the agitation of the water.



HOT PLATE.

The remainder of the apparatus necessary, probably needs no special description and will be merely enumerated.

One air oven, eight by eight by eight inches.

One water bath, copper, with rings.

One rough weighing balance, and weights, ten grams to 500 grams.

One test tube stand.

Four bunsen burners.

Two burette stands with clamps.

One burette stand with rings.

Six iron tripods, eight inches high.

One wooden test tube holder.

One iron mortar and pestle.

One earthenware mortar and pestle.

Two pairs crucible tongs.

One platinum crucible, one ounce capacity.

One dozen porcelain crucibles, one-half ounce capacity.

One six-inch horseshoe magnet.

Six thistle funnel tubes, 12 inches long.

Six bulb tubes, six inches, fitted with two-hole rubber stoppers.

Two 24-ounce flasks, fitted with two-hole rubber stoppers.

One acid dropping bottle.

One dozen 12-ounce beakers, best Bohemian glass.

One dozen 10-ounce beakers, best Bohemian glass.

One dozen five-ounce beakers, best Bohemian glass.

Four 40-ounce beakers, best Bohemian glass.

One 100-ounce beaker, best Bohemian glass.

Four 16-ounce conical flasks.

Four eight-ounce conical flasks.

Six 40-ounce conical flasks.

Six three-inch ribbed glass funnels.

One six-inch glass funnel.

One 1,000 cubic centimeter graduated flask.

One 500 cubic centimeter graduated flask.

One 250 cubic centimeter graduated flask.

One dessicator.

One 100 cubic centimeter measuring glass.

One 25 cubic centimeter measuring glass.

Two dozen test tubes, eight inches by one inch.

Six dozen test tubes, six inches by five-eighths.

Six four-inch watch glasses for beaker covers.

Six three-inch watch glasses.

Six two-inch watch glasses.

One thermometer, up to three hundred degrees Centigrade.

One hydrometer, 1,000 to 2,000 specific gravity.

Two burettes, 50 cubic centimeter capacity.

Two burettes, 25 cubic centimeter capacity.

One pipette, 100 cubic centimeter capacity.

One pipette, 50 cubic centimeter capacity.

One pipette, 25 cubic centimeter capacity.

One pipette, 10 cubic centimeter capacity.

One pipette, five cubic centimeter capacity.

Two wooden filter stands.

Six porcelain dishes, six inches diameter.

Six porcelain dishes, three inches diameter.

One platinum dish, three inches diameter.

The above list is not intended to include everything that may be conveni-

ently provided, but it is sufficient for a laboratory employing one chemist and by its means he can make all the determinations he will ordinarily be called on to make.

These are:

Carbon, by color method.

Graphitic carbon.

Manganese by color or gravimetric method in pig iron or steel. Volumetric method in ferro-manganese, etc.

Silicon.

Sulphur.

Phosphorus.

Complete analysis of coke, limestone, sand, firebrick, and clay.

The list of chemicals and reagents necessary for the above determinations is not large, whilst they vary considerably according to the methods of estimation used. It is understood that all chemicals used for quantitative work must be "chemically pure."

FLUOR SPAR AS A FLUX.

To the Editor of THE FOUNDRY:

In the August number of THE FOUNDRY Mr. D. C. Roberts thinks that I have misled foundrymen in regard to the value of fluor spar as a cupola flux.

Mr. Roberts speaks of the value of fluor spar in basic open-hearth work and of its use in clearing a bunged-up blast furnace, but he does not mention a case of its use in the cupola.

The fact is, that as soon as you use enough fluor spar to flux the coke ash and sand, you also use enough to flux your lining. By using fluor spar in quantity you pay out large money and at the same time wash your fire bricks into cinders.

Speaking with one of the best cupola tenders in New York state, I asked his opinion of fluor spar. He said: "A few years ago I worked for a manager who thought fluor spar was a great thing and I was told to put twenty pounds on every charge of iron along with the limestone. I did so and the manager said there was wonderful improvement in running the furnace, and he thought the iron was improved also. After two months the stock of fluor spar ran out, and as no more came I added a little more limestone to the charges and everything ran as before. The furnace ran well and the manager said the iron was perfectly satisfactory. At the end of three months running without fluor spar the manager says, "Have you got plenty of that fluor spar on hand; it has been giving great results lately." "No," I said, "we haven't had a pound for three months."

As the manager went down stairs he probably said, "I won't give any more fluor spar money to the dickey birds."

Mr. Roberts claims that the use of fluor spar increases the strength of the iron, I tried the iron for strength after using fluor spar and found no difference from the iron made with lime flux. I also tested the iron to find if the phosphorus or sulphur were lower with the same results.

An account of these experiments was published in THE FOUNDRY two years ago, and from the results I judged there was nothing in the claims of the fluor spar promoters.

I am perfectly willing to try Mr. Roberts' barrel, but it would be more satisfactory if Mr. Roberts would put several barrels on the cupola floor and make a practical test of its value. Let the cupola be run for a week with fluor spar then a week with limestone. Compare the fluidity of the cinder, the wear on the cupola, the strength of the iron, and above all, compare the cost of the two fluxes.

If a careful test was made in this manner by a reliable party, then we would know just how much value there is in fluor spar.

Mr. Roberts speaks about fluor spar having a lime efficiency of 50 while limestone has an efficiency of 40. This difference in efficiency counts for little when fluor spar costs ten times as much as limestone does in this part of the country.

Until Mr. Roberts can give the figures of a practical test I will continue to maintain that "limestone is far cheaper than fluor spar and far better as a flux."

N. W. SHED,
Buffalo Foundry Co.,
Buffalo, N. Y.

METALS IN FOUNDRY PRACTICE

Devoted to inquiries from Practical Foundrymen on subjects relating to the Melting and Using of Cast Iron, Malleable Iron and Steel.

The following experts answer questions in this department:

W. J. Keep, Cast Iron.

J. B. Nau, Metallurgy of Steel and Steel Castings.

Dr. Richard Moldenke, Malleable Castings.

We have also made arrangements with several others to act as special contributors. All inquiries should be addressed to the Editor of THE FOUNDRY, and they will then be forwarded to those in charge of the different subjects.

CAST IRON NOTES.

BY W. J. KEEP.

CAUSE OF HARD SPOTS.

Question.—We are having trouble with hard spots in our castings which no tool will cut. These are generally very small and come in clusters. What is the cause and remedy.

Answer.—The cause is generally found in the way the iron enters the mold. If the iron is allowed to fall a sufficient distance to cause a splash when it strikes the mold so that shots are thrown to various points, these shots are solidified before the fluid metal reaches them and a very thin film of oxide covers their surface. When the iron reaches them the oxide forms a gas which is likely to cause a blowhole in the casting and the shot may lie loose in the hole. The shot may partially melt so as to be attached to the casting at one side of the blowhole. Or it may melt sufficiently to become a part of the casting and the gas would work its way out of the casting.

Sometimes in cooling at the spot which cools last a cavity will form and fluid metal from nearby may break through the wall and fill the cavity. In such case this metal is not of the same composition as the main body of the casting or it would have become solid before the cavity formed. This segregated metal is likely to be hard when solid.

A short time ago, in breaking an inch square test-bar made from car wheel iron the fracture showed a perfectly white chilled spot near the center of the test-bar which was no doubt formed by fluid metal running into and filling a blowhole completely.

Aside from pouring a casting so as to prevent splashing of the melted iron, the iron mixture should not be of a chilling nature. It can be easily found which irons will not chill. Shots from non-chilling iron would be gray and would melt when the hot metal flowed over them and would be as soft as any part of the casting.

An increase of silicon will lessen the chill of any iron but there are plenty of brands of iron which will not chill even when run against a chilling plate, in fact such furnaces may be softer than if run against sand.

This can only be found by trial.

Many makers of chilled castings use non-chilling irons and cannot understand why their castings, while white, are not hard.

Others use chilling irons and cannot understand why they are troubled with hard spots. It is not entirely a question of chemical composition, but a natural quality due to the ores and the running of the furnace.

Whenever there is trouble, the best way is to run a test piece against a chill. If the mixture produces a hard chill vary the irons in the mixture until you find which pig iron produces the chill.

EXPANSION OF CAST IRON IN COOLING.

Question.—You say that iron does not expand at the instant of solidification, and it certainly contracts as it loses heat. When does the expansion occur and what is its cause?

Answer.—Text books say that the reason that cast iron fills the delicate ornamentation of a mold more perfectly than most other metals is because the iron expands at the instant that it becomes solid and is forced into the sharp corners.

This has been disproved in many ways, the most convincing fact being that cast iron solidifies one particle at a time on the surface of the mold until a thin pliable skin covers the sur-

face, while the whole central part is fluid and grows smaller as it loses heat and all this while additional particles are becoming solid on the inner surface of the shell. There is a tendency for this shell to pull away from the mold rather than to press into it.

If the shell becomes rigid before it drops away from the mold the central grains will pull away from each other and form spongy spots.

If the shell sinks from the top of the mold it will form a sunken spot in the surface of the casting. Carbon in the form of graphite gives the gray color to the fractured surface of crystallized cast iron.

This same carbon is dissolved in or is combined with the iron when in a fluid state, and remains so until the iron has almost lost its red heat and has become crystalline.

When this last change occurs the casting expands and its temperature temporarily rises in proportion to the amount of graphite that is liberated. There is another earlier but less expansion and rise of temperature on account of phosphorus in the casting.

These expansions occur just as the casting changes from a red heat to a dark color, therefore, in a small casting, which cools quickly, they occur very soon after the whole casting is solid, but much later in a large casting. While these expansions are occurring at different times in different parts of the castings because some portions are larger than others, the casting is contracting from loss of heat, faster in thin than in thick parts.

These powerful opposing forces tend to crack or warp the casting while it is cooling.

In 1895 an autographic machine made curves showing these expansions and contractions which were named "Keep's cooling curves" from the discoverer, and this year Prof. Thomas Turner, of Birmingham, England, has determined the temperature or critical points corresponding to these curves.

PREPARING CASTINGS FOR JAPAN.

Question.—We make copying presses. We polish the surface and then use a filler before applying the finishing coat of paint. Before polishing, we pickle the castings in a sulphuric acid bath.

Will you let me know if stove manufacturers pickle their castings in sulphuric acid before polishing for nickel. One polisher claims that even counting the cost of pickling, he can save 50 per cent in labor and cost of wheels. We use both leather and canvas wheels.

Answer.—It is not good practice to use sulphuric acid for stove plate that is to be nickeled, because the acid soaks into sand holes which always exist though often so small as not to show in the nickel. There is no way to kill the acid at the bottom of these spots. A hydrofluoric acid pickle is not as damaging. A hot lime water will kill the acid on an ordinary surface, but not in deep holes. The acid works out through the nickel weeks after the stoves are packed and shows in quite large leaden stains with a slight black spot in the center.

Your case is not similar and the acid will not injure the painted surface. Again, stove plate is very thin and has no scale, while the scale on your castings must be removed by a pickle to allow a wheel to take hold.

BAKING THE PATTERN IN A DRY SAND MOLD.

Question.—We understand that some parties are making cast gears in dry sand molds and leave the iron pattern in the mold while it is being baked. It is claimed that the pattern expands sufficiently to enlarge the mold, so that when cold the pattern can be readily withdrawn.

What facing or coating is used on the gear patterns to prevent the sand from adhering?

Answer.—A good black wash with plenty of plumbago on the surface of the pattern will allow the pattern to be withdrawn.

THE FOUNDRY

PUBLISHED MONTHLY BY

THE PENTON PUBLISHING CO.

CLEVELAND
BOSTON DULUTH CHICAGO
CINCINNATI NEW YORK
PHILADELPHIA
PITTSBURG

The subscription price of THE FOUNDRY is $1.00 a year to points in the United States, Canada and Mexico. To Great Britain: Eight Shillings. Single copies 15 cents each.

Change of advertising copy must reach this office on the 10th inst. preceding date of publication.

The Cleveland News Company will supply the trade with THE FOUNDRY through the regular channels of the American News Co.

European Agents: The International News Company, Breams Building, Chancery Lane, London, E. C., England.

Practical articles pertaining to the trade in all its branches are solicited and will be paid for.

When sending articles be sure to place your name and address on the article and on the drawings.

Entered as second-class matter at the Post-Office at Cleveland, Ohio.

PRINTED IN AN OPEN SHOP.

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TRADE OUTLOOK.

The foundry trade outlook, as far as volume of business on hand and other similar conditions in the foundry, is very much as it was last month, but the raw material proposition is becoming more serious. The furnaces in all parts of the country have sold practically all of the material which they now have on hand and most of them have orders booked for a long time in the future. The result is that the price of foundry iron is constantly advancing. Pig iron for steel making is becoming especially scarce, while foundry iron is not as plentiful as the foundryman might wish. In both Chicago and Cleveland No. 2 foundry has been sold for $20 per ton. No. 2 foundry is quoted at the valley furnaces at $18.25, while in the south No. 2 foundry is quoted at $14.75, Birmingham. The southern furnaces are sold out almost as closely as the northern, and hence the foundrymen cannot look to the south for relief in the face of the impending iron shortage. Many large firms have purchased their iron for the first quarter of 1907.

If it were not for the present extensive use of by-product coke in the foundry industry the foundrymen would have very great difficulty in securing fuel, and as it is, with winter approaching, it behooves all foundrymen to get as much of the winter's supply of coke into the foundry yard as possible before cold weather sets in.

In spite of the fact that seven blast furnaces having an annual capacity of 880,000 tons of pig iron have been blown in since Dec. 31, 1906, and that there are 16 furnaces now in course of construction, the product will not be more than enough to meet the very heavy demand which promises to continue through next year. *The Iron Trade Review* estimates that the pig iron production for 1906 will be 25,750,000 tons; for 1907, 27,250,000, and in 1908, 28,180,000. This would make the year 1908 show an increase over the actual product of 1905 of less than 23 per cent. In the three years from 1902 to 1905 the increase was 29 per cent. The evidences are, therefore, that the blast furnaces

now being built will not increase pig iron capacity at the rate which the market has heretofore stood and stood extremely well, considering the almost famine condition prevailing at the present time.

BRITISH FOUNDRYMEN'S ASSOCIATION.

We are glad to be able to present in this issue of THE FOUNDRY a report of a portion of the meeting of the British Foundrymen's Association, and expect to publish the balance of the report in the October issue. This meeting was marked with many pleasing features which showed the growth of the interest in the scientific or advanced side of the foundry industry in Great Britain. The old rule of thumb methods are fast passing away and the foundry is being recognized as one of the advanced departments of any manufacturing concern, which is the position which it should occupy. Modern conditions demand expert metallurgical work in the production of castings of all kinds, and it is only by meeting together, exchanging ideas, and assisting one another that the foundrymen of any country can arrive at the greatest degree of perfection.

The papers read before the Middlesbrough meeting were well discussed and showed the deep interest taken in these subjects by the more progressive British foundrymen. The advance movement of any trade in any country is usually marked with more or less conservatism and with many disappointments, but the healthy growth of the British Foundrymen's Association shows that its able officers and members are overcoming these prejudices and difficulties and laying the foundation for a great and grand future, not only for this association, but for advanced foundry practice in Great Britain.

It has been said that the greatest secret of American success in manufacturing lines lay in the help-one-another policy displayed by manufacturers in kindred lines. Such helpfulness as this saves an enormous waste of energy, which results when each manufacturer has to work out all the details of all the different processes for himself.

It has been said that the electric generator has done more for the development of the steam engine through its exacting requirements than all other factors which have ever entered the power generation field, and in like manner the requirement for high grade casting is today forcing the foundrymen to produce better and more uniform castings, and the foundrymen's requirements are in turn forcing men to more careful work in the production of raw metal and in its sorting, grading and analysis.

The foundrymen's association may be considered as a sort of clearing house through which these changes in the foundry field are arranged, and hence an active association will be to the British foundry trade what a good clearing house is to a banking system in any community, that is, it will facilitate development and trade to the greatest possible extent.

PERMANENT MOLDS.

There has been a good deal of discussion in the trade papers from time to time about the use of permanent molds, or molds having permanent parts, and in this connection the article published in another part of this issue, which was contributed by Mr. George W. Kelly, is of special interest. Mr. Kelly's entire molding experience has been in Columbus, Ga., where he is employed by the Golden's Foundry & Machine Co., but it is evident from the article and from other facts which we have heard of Mr. Kelly, that he is an original thinker and a man ready to try anything that appears feasible. We would be very glad indeed to receive other articles along the same lines, as it is certain that this style of molding could be applied to a large variety of work with advantage.

ASSOCIATIONS AND SOCIETIES.

Proceedings of the Newly Organized Foundry Foremen's Association Of North Germany.

The gathering was called to order by the president of the Foundry Foremen's

Association of Hannover, who after calling attention to the great need of an organization of this kind, introduced the president of the German General Foremen's Association, who in turn welcomed the foundry foremen present, and saw in the gathering an additional advantage to come for the men who stood between the employers and employes.

Reports were presented from the South German Foundry Foremen's Association, also from the Berlin Foundry Foremen's Association, which was now in the 34th year of its existence.

In the discussion of the proposed constitution, at the paragraph relating to the annual dues, it was suggested that this was imporant inasmuch as "the members would also like to hear papers read, and these cost money." American associations have not yet arrived at the point of paying for papers presented before them.

After the adoption of the constitution, the arrangement for two conventions annually, and the selection of Hamburg for the next meeting place, the gathering adjourned for a "Kommers" which lasted until the early morning hours. Next day the foundry of the United Emery & Machine Co., was visited, and the gathering then adjourned.

From the details of the proceedings it would appear that there exists a German National Association of Foremen, which looks after the welfare of its members in sickness and helps them to positions. The foundry part of this, however, never amounted to anything as the officers of the general body had no understanding for the needs of the foundry foreman. Hence the organization of special associations for foundry foremen only, and these based upon the educational principle as America has it. There are, however, local foundry foremen's associations, such as Berlin, Canstratt, etc., which have existed for many years on the sick benefit principle.

Cincinnati Foundry Foremen.

E. W. Cadwell, Secretary, care S. C. Tatum Co.

The regular meeting of the Cincinnati foundry foremen was held on July 28, with 18 members present. One new member was elected and a paper on "What Constitutes a Practical and Progressive Foundry Foreman" was read by F. W. Wiessmann, one of the members of the association. This paper was quite extensively discussed. The secretary reports that the Cincinnati association is now progressing very nicely, in fact, is on the boom.

Milwaukee Foundry Foremen's Association.

Julius Germanson, 931 Allis street, Milwaukee, Wis., secretary.

The regular meeting of the Milwaukee Foundry Foremen's Association was held Aug. 6. The meeting was called to order by President Glasscock, and the regular routine business transacted, after which there was a general discussion as to the condition of the various shops and the work which the men had in hand. The meeting was very interesting and the discussion taken part in by a large number.

NEW ENGLAND FOUNDRYMEN'S ASSOCIATION.

Fred F. Stockwell, Secretary, care of the Barbour-Stockwell Co., Cambridgeport, Mass.

PHILADELPHIA FOUNDRYMEN'S ASSOCIATION.

Howard Evans, Secretary, care J. W. Paxson Co.

PITTSBURG FOUNDRYMEN'S ASSOCIATION.

F. H. Zimmers, Secretary, care Union Foundry and Machine Co., West Carson Street.

PACIFIC COAST FOUNDRYMEN'S ASSOCIATION.

J. D. Morris, Secretary and Treasurer, Seattle, Washington.

BUFFALO FOUNDRYMEN'S A S OIA N.

John E. Gorss, Secretary, 23 Builders' Exchange.

THE ASSOCIATED FOUNDRY FOREMEN.

Frank C. Everitt, care the J. L. Mott Iron Works, Trenton, N. J., Secretary.

CLEVELAND FOUNDRY FOREME

H. M. Lane, 610 Schofield Bldg., Secretary.

NEW YORK FOUNDRY FOREMEN'S ASSOCIATION.

C. H. Thomas, 14 Elizabeth St., So. Norwalk, Conn., District Vice President.

ERIE FOUNDRY FOREMEN.

W. F. Grunau, Dist. Vice Pres., care Erie City Iron Works.

INDIANAPOLIS FOUNDRY FOREMEN.

W. S. Keller, of Hetherington & Berner Co., District Vice President.

HAMILTON, ONT., FOUNDRY FOREMEN'S ASSOCIATION.

A. Chase, care Sawyer & Massey Co., Secretary and Treasurer.

MONTREAL FOUNDRY FOREMEN.

Mr. J. F. Gaffney, care of Allis-Chalmers-Bullock Co.

PHILADELPHIA FOUNDRY FOREMEN.

John B. MacMeekin, The Abraham Cox Stove Co., Secretary.

CHICAGO FOUNDRY FOREMEN.

Mr. Thompson, Link Belt Co., District Vice Pres.

A JOBBING MOLDING MACHINE.

Most molding machines are suitable only for work which is to be turned out in large quantities, and the general jobbing foundryman has long been

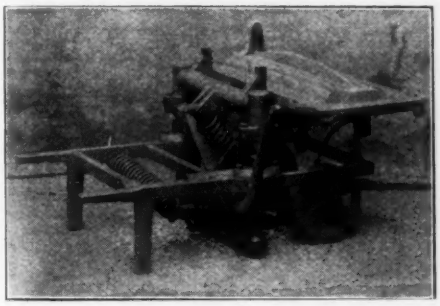

FIG. 1.—MACHINE AND PATTERN.

looking for a machine which could be made to do such a large variety of standard work as is constantly coming into the ordinary jobbing foundry. Practically all of the molding machines on the market today are only helps in the production of the mold, that is, each class of machine is planned to do some specific part of the work. More molds are spoiled in the drawing of the pattern than in any other part of the operation, and hence for a large variety of work a machine capable of rolling over the flank and then drawing the pattern up out of the sand possesses certain marked advantages.

Recognizing this fact, the Tabor Mfg. Co., of Philadelphia, has recently developed a new machine which be-

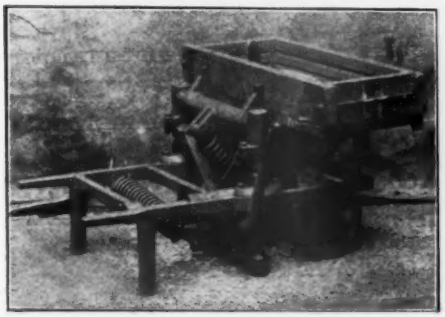

FIG. 2.—FLASK IN POSITION.

longs to the roll over class and possesses many advantages. The one shown in Fig. 1 is a medium size machine intended for molds which can be handled by one man. It is called a 24-inch hinge machine, with 7-inch straight draft. Similar machines are

FIG. 3.—RAMMING THE MOLD.

made in other sizes, some of which are so large that they have to be set in a pit and the work rolled over and handled by a crane.

The first point which presents itself upon looking at the machine is that it is portable and can be run along the sand heap by lifting the handles

at the rear and trundling the machine forward on the wheels shown, just as a two-wheeled wheel-barrow would be handled. The pattern plate is supported by two arms or brackets which are shown more clearly in some of the later illustrations, as for instance, Fig. 5.

In the example shown in the first eight figures, the molding machine is equipped with an iron plate upon

FIG. 4.—MOLD READY TO ROLL OVER.

which is mounted a grate bar pattern having a large number of pockets. Of course an iron plate and metal pattern would only be used where a large number of castings are required, but this pattern serves to show the operation of the machine, while its jobbing facilities will be discussed later. In making the mold the flask is first put on as shown in Fig. 2, rammed up either by hand or with a pneumatic

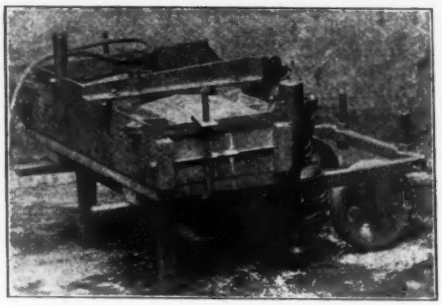

FIG. 5.—MOLD ROLLED OVER.

rammer, as shown in Fig. 3. The bottom board is then clamped on as shown in Fig. 4. It may be mentioned that this figure also shows the Tabor adjustable clamp, which works on the self-locking ratchet principle and can be adjusted instantly to any depth of flask within the range of the clamp bar. Such a clamp is also very easily removed, but is not likely to come loose during the operation of turning over the mold.

It will be noticed that the mold is balanced by a spring shown in a diagonal position in Figs. 1 and 4. After the bottom board is on the operator turns the mold over, the operation being greatly facilitated by this spring, the tension of which is adjusted to suit the weight of the flask in use. In some of the larger machines a number of springs are used side by side. The tension of these can be varied, or one or more of the springs thrown out of use when small work is being put up. The mold, rolled over and ready for the drawing of the pattern, is shown in Fig. 5. In the machine shown a vibrator is attached to assist

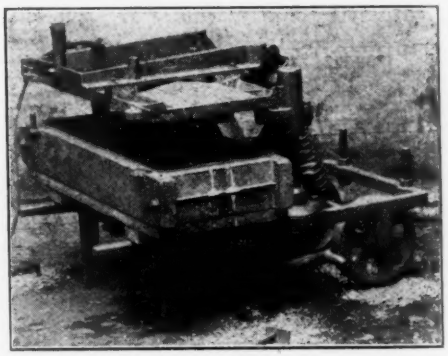

FIG. 6.—PATTERN DRAWN.

in drawing the pattern and in foundries not equipped with compressed air the pattern may be rapped with a mallet and, in fact, very complicated work can be turned out in this way with entire satisfaction. A power vibrator, however, has the advantage that it operates uniformly during the entire operation of drawing the pattern and hence is far less liable to result in an injury to the mold.

At this point the principal theoretical objection to a machine of this type may be mentioned and this is that the pattern board is rocked over on to a surface other than that which the mold occupied when it was rammed,

and if the board does not fit accurately upon the surface receiving it the mold may be tilted so that in drawing the pattern it will have a tendency to shear off the corners of the mold. A little care in the selection and fitting of the bottom boards to see that they are bedded firmly upon the machine before drawing the pattern will go a long way toward assisting in the production of true castings.

The use of a vibrator on the machine has an advantage in this connection, which is that even if the mold should

FIG. 7.—ROLLING THE PATTERN BACK.

be slightly tilted, the continuous action of the vibrator will probably permit of the drawing of the pattern without seriously distorting the mold, though it will of necessity disturb the sand to some extent. In practical work, however, upon the majority of the patterns for which this machine is fitted these objections have turned out to be more fancy than fact and the proof of the pudding is found in the eating. In other words, this machine is continually turning out good castings without any serious trouble arising from the cause mentioned.

This brings us to one of the statements made at the first of this article, that no molding machine performed all operations and that some brain work is necessary in all cases.

After the mold has been turned over in the position shown in Fig. 5 the clamps are knocked off, the vibrator

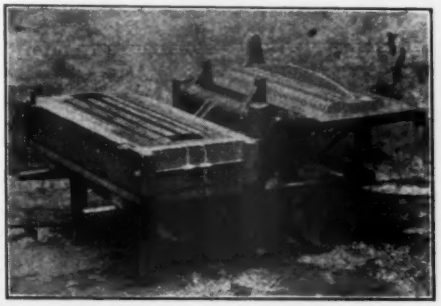

FIG. 8.—PATTERN ROLLED BACK.

started, and the lever shown at the center of the machine in the foreground is moved down as shown in Fig. 6. This lifts the pattern clear of the mold and while being lifted the pattern is accurately guided by vertical guides. Once the pattern is free from the mold it is turned over, this operation being shown in Fig. 7. It will be noticed that the pattern is turned over, while in its uppermost or drawn position. After turning the

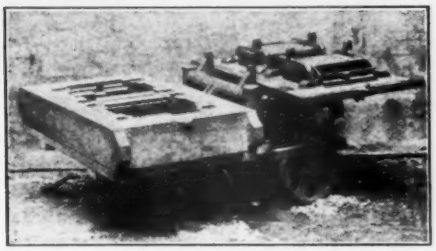

FIG. 9.—A SPLIT PATTERN MOUNTED FOR MOLDING.

pattern out of the way of the mold it is lowered into the first position, as shown in Fig. 8, when it is ready for the reception of another flask. It is claimed by the makers that this machine is suitable for printing back, but on account of the fact that the mold, when rolled over, is received on a surface which will probably never be absolutely true or parallel to the surface of the pattern board it is probable that more or less difficulty will be en-

countered in an attempt to print back molds having any considerable depth, and it would probably give more or less trouble even in flat back work. The cope for the mold shown in Figs. 1 to 8 is an ordinary flat back which is rammed up on the floor and placed upon the drag after it is in position. This machine, however, may be used for the production of castings from split patterns by mounting both the cope and drag parts of the pattern upon one pattern plate, as shown in Fig. 9. In this case the copes and drags are exactly alike and in closing the molds it is necessary to turn the copes end for end so as to bring the two parts of the mold into the proper relationship. This results in one casting being poured with one side up and the other in the reverse position. For large work or in the case of castings which must be poured with a certain side down, two machines are necessary or two separate pattern plates must be arranged and all of the drags molded first, the pattern plate changed and the copes molded and the molds closed.

In the case of ordinary flat back work it is not necessary to use any gaggers in the molds, but when doing split pattern work in large flasks, it may be necessary to use some bars and gaggers in the cope flasks, as it is necessary to turn these over after they are molded during the operation of closing the mold.

Some idea of the adaptability of the machine may be gained from Fig. 10, which shows a large variety of work mounted on pattern boards ready for use on the machine. Some of it is flat back work, but most of the pieces are split pattern work necessitating the turning of the cope end for end when closing the mold.

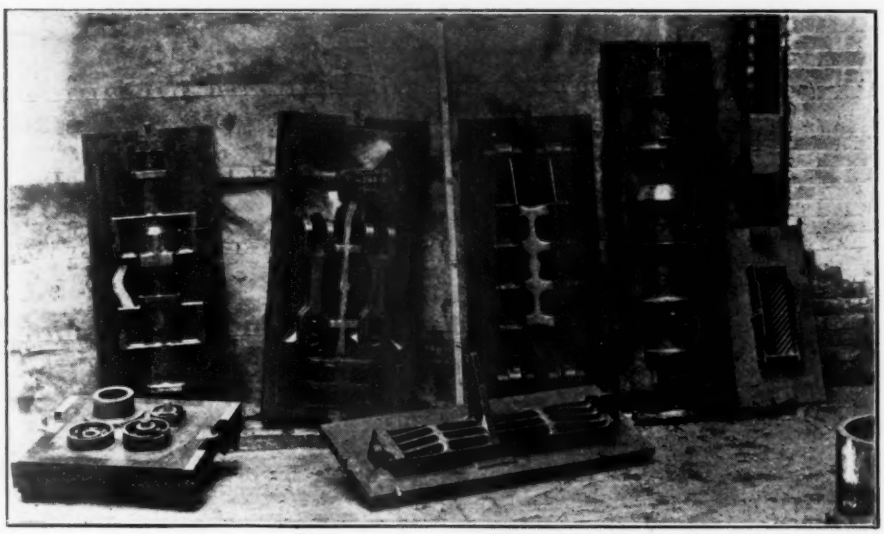

FIG. 10.—PATTERN BOARDS.

The method of attaching the pattern plates to the machine is interesting. Metal pattern plates are bolted to the machine by turned bolts passing through reamed holes, which insures the accurate location of the pattern plate in all cases. Wooden pattern plates are provided with dowels, which fit these same reamed holes and are secured to the machine by buttons or special clamps. This method of attaching the wooden plates makes it possible to change from one pattern to another instantly, so that changing from one pattern to another occupies no more time than it would in ordinary floor molding. In the case of flat back work the patterns are usually removed from the pattern boards and

stored in the ordinary way. In the case of split pattern work, however, it is necessary to locate the pattern accurately upon the pattern boards and hence the pattern board and pattern should be stored together.

A jobbing foundry having a good man to look after the equipment of such a molding machine should be able to turn out a very large variety of work upon this machine very much more rapidly and cheaply than it can be made by the ordinary floor methods. The portable feature of the machine should also appeal strongly to the jobbing foundryman. One of the greatest advantages of the machine is that it is possible to put up such a large variety of work upon it for a single heat. The writer saw six separate molds made in less than an hour upon the machine by changing the pattern plate for each mold. These molds varied from 16 by 20 up to 22 by 50. The fact that the accurate drawing feature of the machine practically insures a perfect mold, which will require no slicking if the ramming has been properly done, taken in connection with the quick changes which can be made and the fact that the operators do not have to be skilled molders, should make this machine very popular indeed.

PERSONALS.

Amos Kells, who has long been identified with the Kells Foundry & Machine Co., of Adrian, Mich., has resigned his position with that company to become superintendent of the Adrian Steel Casting Co., of the same city.

F. K. Shults has been appointed sales agent of the American Steel Foundries and of the Simplex Railway Appliance Co., with headquarters in New York city.

William Burns, assistant superintendent of the Pennsylvania Steel Casting Co., at Chester, Pa., has entered the service of the Baldwin Locomotive Works, at Eddystone, Pa.

Thomas H. Roberts has retired as general superintendent of the J. D. Connell Iron Works, New Orleans, La., to accept a similar position with the Stern Foundry & Machine Co. of the same city.

Gilbert Prentiss, general manager of the Racine, Wis., plant of the American Skein & Foundry Co., has resigned. No successor has been appointed, his duties having been assumed by other officers.

Benj. D. Fuller, who has been in charge of the Allegheny foundry of the Westinghouse Electric & Mfg. Co., has been appointed general superintendent of the company's plants in Allegheny and Cleveland, O.

H. Van Atta has retired from the superintendency of the J. L. Mott Iron Works, of Trenton, N. J.

W. S. Allen, of Pittsburg, has been made superintendent of the Sharon Foundry Co., at Wheatland, Pa., to succeed P. J. McManus, who recently resigned.

Mr. Arthur Appleton has been made resident manager of the New York office, at 45 Broadway, of Pawling & Harnischfeger, Milwaukee, Wis, builders of traveling cranes, and will represent this firm's interests in and about New York city, the New England states and Eastern Canada. Mr. Appleton was formerly associated with Wm. Sellers & Co., Philadelphia, for many years, as traveling salesman.

DEATHS.

John S. Newmyer, for several years general manager of the Washington Coal & Coke Co., died recently at his home at Dawson, Pa., at the age of 59. Mr. Newmyer was first associated with his father under the name of Newmyer & Son, in the coal and coke business. Later he became one of the pioneer coke operators of the lower Connellsville region, and in 1892 he chartered the Washington Coal & Coke Co., and was elected manager, which position he held at the time of his death.

Joshua Regester, for many years engaged in bell casting and brass founding, died at Baltimore, July 31, at the age of 90. He was born in Maryland in 1816, and at the age of 16 entered the employ of the Sharrer Brass Works, Baltimore. In 1844 he organized the

firm of Clampett & Regester, which subsequently became Regester & Webb, then Joshua Regester and next J. Regester & Son. He leaves a widow and four children.

FIRES.

The Fort Wayne Foundry & Machine Co., Fort Wayne, Ind., sustained a loss of between $5,000 and $10,000 July 30, when the plant was visited by fire. Heavy damage was done in the pattern storage room.

The brass foundry of William Duncan, Boston, Mass., was damaged by fire on July 27, to the extent of $4,000.

The Sheffield Stove Works, of Sheffield, Ala., owned and operated by B. B. Cohen, was destroyed by fire on July 25, with a loss estimated at from $15,000 to $20,000, partly covered by insurance. Many valuable patterns were destroyed.

The Eagle Brass Foundry, Seattle, Wash., conducted by James Tracy, was destroyed by fire on July 12, resulting in a loss of $10,000, which is partly covered by insurance. While trying to save some valuable records of the firm Mr. Tracy was seriously burned.

The plant of the Griffin Wheel Works, St. Paul, Minn., was recently destroyed by fire, resulting in a loss of $10,000.

The plant of the Western Iron Works, St. Paul, Minn., was destroyed by fire July 26, with a loss of $40,000, partly covered by insurance.

NEW CONSTRUCTION.

The Ansonia Mfg. Co., Ansonia Conn., maker of brass goods, is building an addition two stories high, of steel and concrete construction, 50 x 200 feet.

Clarence H. Josslyn, Lawrence, Mass., has under construction foundry buildings which will cost about $60,000.

The Davis & Farnum Mfg. Co., Waltham, Mass., is building an addition 59 x 150 feet to its foundry.

A foundry building 100 x 200 feet, with an ell 75 x 100 feet, is being added to the plant of the Merrimac Iron Foundry, Lawrence, Mass.

Mackintosh, Hemphill & Co., of Pittsburg, on account of their rapidly increasing business in the steel casting department, are installing a 25-ton acid, open-hearth furnace and making other improvements, including the installation of a new air compressor and electric cranes. The end of the old ingot mold foundry is being torn out, uniting it with the present steel foundry of the company and doubling the capacity of this department, giving a daily capacity of 70 tons of steel castings.

The National Radiator Co., Johnstown, Pa., is making extensive improvements to its plant to take care of its growing business. The additions will increase the capacity of the works about 40 per cent.

The Lancaster Machine & Structural Works is erecting a new plant at North Lancaster, Pa., which will include a foundry, structural shop, machine shop, and a fire-proof pattern shop of cement construction. Complete foundry equipment will be purchased.

The Standard Foundry & Steel Casting Co., recently organized at Pittsburg, Pa., will erect a steel foundry near that city.

Confer, Smith & Co., Hamburg, Pa., are extending their foundry to provide fitting and shipping rooms for stoves and other castings.

The Kiskiminetas Mfg. Co., of Avonmore, Pa., is rebuilding its brass foundry which was recently burned.

John M. Evans, of Boston, Mass., representing eastern capitalists, has secured an option on 40 acres of land along Crab Creek just north of Youngstown, O., on which it is proposed to erect a large iron forge and casting plant. Mr. Evans was formerly a resident of Youngstown.

The Challingsworth Foundry & Machine Co., of Mt. Vernon, O., has placed a contract with the Mt. Vernon Bridge Works, of Mt. Vernon, for an extension of more than 12,000 square ft. to its present foundry building, and has lately installed another 20-ton Case traveling crane, air compressors, etc. These improvements will make the plant one of the best equipped jobbing foundries in Ohio.

The W. W. Sly Mfg. Co., Cleveland, O., has taken out a permit for a gray iron foundry.

The United States Malleable Iron Co., Toledo, O., has prepared plans for a 10-ton melting furnace and five annealing ovens, and expects to have them in operation within sixty days.

The Standard Brass Mfg. Co., Cleveland, O., has awarded the contract for a new foundry building, 60 x 75 feet.

The Niles Tool Works Co., Hamilton, O., is making plans for extensions to its machine shop, foundry and blacksmith shop.

The Greaves & Klusman Co., Cincinnati, O., has been granted a permit for a one-story brick pattern shop.

Plans are being prepared for the new plant of the Toledo Steel Casting Co., recently incorporated by Chas. A. Parsons and others, of Toledo, O., by the Schlieper Engineering Co., of Pittsburg. The plant will include a main building 110 x 420 feet, of steel construction, machine shop, pattern shop, storage house and power plant. Two 20-ton basic open hearth furnaces will be installed.

The Superior Foundry Co., Cleveland, O., will add a new core room and molding room, 85 x 160 feet, and a two-story office building to its plant and install a 15-ton cupola. These improvements will increase the capacity of the plant about 25 per cent.

The Leonard Stove Co., Bowling Green, O., which recently lost its plant by fire, is rebuilding.

The United States Cast Iron Pipe & Foundry Co. is adding several new buildings to its plant at Addyston, O.

Improvements for which contracts have been let by the Fanner Mfg. Co., Cleveland, O., include one building 135 x 400 feet, to be used as a malleable and gray iron foundry, and a structure 75 x 350 feet to be used for power, annealing and assembling purposes. In this new foundry the company will employ about 240 molders. Construction work will be completed in four months.

The Zanesville Malleable Iron Co. is to double the capacity of its plant at Zanesville, O. An addition to the foundry 160 x 200 feet, will be erected, and a 15-ton melting furnace installed. The annealing room will be extended a distance of 100 feet and will be equipped with five new 20-ton annealing furnaces.

Plans are being prepared by Cook Bros., Detroit, Mich., for the new plant of the Bellevue Pipe & Foundry Co., Bellevue, O., which was lately incorated by H. D. Keller and Thomas E. Robinson, of Detroit, who are at the head of the Northwestern Foundry & Supply Co., and other capitalists of Bellevue, O.

The D. T. Williams Valve Co., Cincinnati, O., expects to have its plant for the manufacture of valves, oil cups, etc., ready for operation by Jan. 1. The main building will be 125 x 247 feet, four stories in height, with a foundry on the top floor.

It is reported that the Spring Drill Co., of Peru, Ind., is planning the construction of a large foundry building.

George Clark has purchased a site in Mishawaka, Ind., on which he will erect a factory and foundry building 40 x 60 feet, for the manufacture of aluminum shoe and boot lasts.

Reeves & Co., Columbus, Ind., are planning an addition to their foundry, 60 x 100 feet, which will make room for fourteen additional molders.

Plans are being prepared by the Osborn Engineering Co., of Cleveland, for extensive improvements to the plant of the American Seeding Machine Co., Richmond, Ind., which will double the capacity of the present plant. There are to be nine new buildings and the plant when finished will cover two blocks, and have 150,000 square feet of available floor space. The plant will include a new foundry, 150 x 200 feet, blacksmith shop, 93 x 215 feet, pattern shop, 50 x 70, a four-story assembling and storage building, etc.

The Hoosier Stove Co., Marion, Ind., is constructing a new plant, including an office building, mounting room, foundry, rattling room and pat-

tern room. The buildings, which are of steel construction, will be ready for occupancy by November.

The plant of the Congress Foundry Co., Chicago, Ill., which began operation a year ago, making high grade castings for automobile and gasoline motors, is being enlarged to enable the company to employ twenty-five more molders. The foundry output will then be ten tons of finished castings daily. P. McGuire is superintendent of the plant.

Extensive additions to the foundry of Williams, White & Co., Moline, Ill., are being considered. Present plans provide for a structure about 135 feet square to occupy the ground between the machine shop and pattern department as an ell to the present foundry.

The American Bell & Foundry Co., Northville, Mich., is to build an addition to its foundry, 40 x 70 feet, which will cost approximately $3,000.

The Northern Malleable Iron Co., St. Paul, Minn., has purchased a seven-acre tract of land in that city, and will at once begin the construction of a $100,000 plant which it expects to have in operation by Dec. 1. 300 men are employed at the present plant, and it is expected that the new one will require 500.

The new foundry of A. C. Welling, Niles, Mich., is now practically completed. It is a brick building, 38 x 112 feet, including foundry and machine shop, and will be used for the manufacture of the Welling furnace.

Work has been started on the new foundry of Hosler & Conklin, at Eaton Rapids, Mich.

The lately organized South Side Steel & Malleable Casting Co., of Milwaukee, Wis., has its new foundry, 160 x 260 feet, well under way.

Charles Clarage is to build a brick addition to his foundry in Kalamazoo, Mich.

A one-story pattern shop 83 x 144 feet is to be built by C. P. and J. L. Lauson, at Milwaukee.

The Nott Fire Engine Co., Minneapolis, Minn., is adding a brass foundry and making other improvements to its plant.

The Monroe Foundry & Furnace Co., Monroe, Mich., is making extensive improvements to its plant, including a new pattern shop.

The Acme Iron Bed Co., St. Paul, Minn., is installing a new cupola and enlarging its foundry. These improvements will enable the company to double its output.

The Minneapolis Steel & Machinery Co., Minneapolis, Minn., is building an addition to its foundry, 80 x 100 feet, and will equip it with four large ovens for use as a core room.

The Washburn Steel Co., Minneapolis, Minn., is preparing plans for a new plant, consisting of an office building, machine shop, foundry, pattern shop, storage building, and laboratory.

The Albion Malleable Iron Co., Albion, Mich., has begun the erection of additions which will increase its present output to about 18,000 tons of finished castings annually. Six furnaces will be operated and 300 molders employed. It is expected that the work will be completed by Dec. 1.

T. Shriver & Co., 333 East Fifty-sixth street, New York, are erecting a new building at Harrisburg, N. J., for the manufacture of castings.

The Virginia Pipe & Foundry Co., Richmond, Va., has begun the manufacture of soil pipe and fittings in its new plant on Belle Isle. The main building is 110 x 190 feet, and is equipped with the best of modern machinery. Sixty men are employed and the company expects to increase its force rapidly.

H. R. Romberger and others of Winona, Miss., have organized a company with a capital of $25,000 to erect a foundry and machine shop.

The Cahill Iron Works is making extensive improvements to its plant at Chattanooga, Tenn.

Work has begun on the plant which the Globe Foundry Co. of Port Chester, N. Y., is erecting at Huntington, W. Va. This plant will employ 200 men at the start, and later 500, and it is expected that about 200 tons of iron will

be melted daily when the plant is in full operation.

The Gadsden Foundry Co., Gadsden, Ala., has contracted to build a modern brass and iron foundry in that city. The main building will be 30 x 100 feet and in addition there will be an engine, pattern and cleaning rooms. All kinds of brass and iron castings will be made.

The Wheeling Mold & Foundry Co., Wheeling, W. Va., is preparing plans for the construction of a steel foundry in connection with its present plant, and will start with one 25-ton steel furnace. All sizes of steel castings will be made.

The Western Mfg. & Supply Co. has taken out a permit for a foundry building in Berkeley, Cal. A machine shop will be added later.

The Downie-Wright Mfg. Co. has begun the operation of its new foundry and machine shops at Rapid City, S. D., with thirty men, and expects to greatly increase its force later. Mining and milling machinery, power transmitting machinery, etc., will be manufactured.

The Collins-Gunther Mfg. Co., San Antonio, Tex., is beginning work on a new plant, which will include a large foundry and machine shops. More than $50,000 will be spent on the plant, which is to be completed by Jan. 1.

The Olympic Foundry Co., Georgetown, Wash., has its new foundry plant, including a main building, 92 x 200 feet, with another building for offices, pattern shop, etc., nearly ready for operation.

The N. S. Sherman Machine Co., Oklahoma, Okla., is building a new foundry 50 x 100 feet, with a wing 35 x 45 feet, and will equip it with the most improved machinery. About $18,000 will be spent on the plant and equipment.

The Scullin-Gallagher Iron & Steel Co., St. Louis, Mo., has taken out a permit for a steel foundry building 60 x 280 feet, to cost $15,000.

The Union Iron Works Co., of Spokane, Wash., is doubling the size of its plant, at an expenditure of $100,000. A foundry, 48 x 182 feet, is being erected, together with core rooms, assembling room, etc., and the working force will soon be greatly increased.

The Webb City Iron Works, Webb City, Mo., is erecting a steel and brick structure to cost approximately $50,000. This will contain pattern rooms, machine shops, foundry, and office, and will be equipped with the most modern machinery throughout.

The Seattle Foundry Co., Seattle, Wash., which was incorporated in April, has been reorganized with a capital of $30,000 and will hereafter be known as the N. & S. Foundry Co. A foundry building 45 x 85 feet and a pattern and storage building will be erected as soon as plans can be prepared.

The Spokane Machinery & Supply Co., Spokane, Wash., is now occupying its new plant for manufacturing machinery and supplies for saw mills and ice plants. The buildings include a machine shop, foundry, pattern shop, warehouse, blacksmith shop, etc.

The National Iron Works, Spokane, Wash., is shortly to move to a site recently purchased along the O. R. & N. railway tracks, where a plant to double the capacity of that now occupied will be erected. Considerable machinery will be required for the equipment of the new plant.

The Canada Foundry Co., Toronto, Ont., has practically completed its new pipe foundry, which will have a capacity of 60 tons daily.

The Western Foundry Co., which in addition to its extensive works in the United States, has large plants in Montreal and Windsor, Canada, has purchased a site comprising three and a half acres south of the Canadian Pacific railway shops in Winnipeg, Manitoba, and will establish a plant there.

The Monarch Brass Mfg. Co., Port Colborne, Ont., is preparing plans for an addition which will more than double the capacity of its present plant.

GENERAL INDUSTRIAL NOTES.

The K. C. Schmidt Co., dealer in foundry supplies, of San Francisco, Cal., calls our attention to the fact that it has found a new home since the fire at the southeast corner of

Brannan and Harriet streets, San Francisco, and is ready to cater to the requirements of Pacific coast foundrymen once more.

The Farrell Foundry & Machine Co., Ansonia, Conn., has increased its capitalization from $1,150,000 to $1,200,000.

The real estate and buildings of the Shaw Machine Co., Lowell, Mass., has been sold to Mr. Benjamin, 260 Summer street, Boston, representing the American Woolen Co., for $65,000.

The Salem Sashweight Foundry, Inc., Salem, Mass., has been incorporated with a capital of $2,000, to deal in sash weights and do a general foundry business. The incorporators are Horace N. Smith, Alonzo H. Smith, of Salem, and Addison S. Hodges, of Somerville.

The James Brown Machine Co.'s plant at Pawtucket, R. I., has been sold to a Boston syndicate, which, it is reported, will build a duplicate of the present structure and operate the entire plant.

R. J. Morrison, of New York, has purchased the Plymouth stove foundry, Plymouth, Mass., and will operate the plant, which has been closed since the death of the former proprietor.

The Ireland Machine & Foundry Co. has been incorporated with a capitalization of $25,000 to manufacture machines, tools and implements. The incorporators are A. Burtsell Ireland, Frank L. Ireland and Herbert A. Ireland, all of Greene, N. Y.

The Keystone Brake Shoe Co., incorporated with a capital of $500,000, will manufacture railway supplies. The incorporators are Chas. H. Platt, 12 East 23d street, James J. Allen and Charles A. Decker, 100 Broadway, all of New York.

The Parsons Lane Co., incorporated with a capital stock of $10,000, will manufacture tools, metal castings, etc. The incorporators are William N. Parsons, Augustus H. Lane, William T. Gaylord, all of Sodus, N. Y., and others.

The J. G. Brill Co., Philadelphia, which has been incorporated at Harrisburg, Pa., with a nominal capitalization of $50,000, will take over the car-building plants now owned by the Brill interests. These include the works at Philadelphia, the American Car Co.'s plant at St. Louis, the John Stephenson Co.'s plant at Elizabeth, N. J., and the Kuhlman plant at Cleveland, O. A fifth plant located in Massachusetts will also be taken over and the present capitalization of the company will be greatly increased.

The Pottsville Foundry & Stove Co., Pottsville, Pa., has been formed by S. F. Laucks and F. S. MacMillan, of York, Pa., and Charles F. Derr, of Pottsville. The capital stock is $25,000.

The incorporation of the Herman Pneumatic Machine Tool Co., of Zelienople, Pa., marks a decided change in the old firm of Chas. Herman & Son, formerly of Sharpsburg, Pa. The business of manufacuring the Herman jarring molding machine had increased so rapidly that it was necessary to obtain new quarters. It was also necessary to obtain more capital so as to operate on a larger scale. This necessitated the move mentioned. The works are located 34 miles west of Pittsburg on the main line of the Baltimore & Ohio R. R. Connection is also made with the Buffalo, Rochester & Pittsburg R. R. The purpose of the incorporation is not only to make the Herman pneumatic jarring molding machine, but also to manufacture a full line of pneumatic machinery for foundries, including rotary sand sifters, air hoists and other labor-saving devices.

W. W. Shilling, of Sharon, Pa., has been elected president of the Sharon Foundry Co., of the same city, and Thomas Kennedy secretary and treasurer. The old board of directors has been re-elected.

The new company recently organized to take over the business of the

late Daniel M. Curry, of Danville, Pa., will be known as the Danville Foundry & Machine Co.

The Ferro Machine & Foundry Co., of Cleveland, has increased its capital stock from $250,000 to $283,000.

The Ohio Elevator & Machine Co., Columbus, O., has been incorporated for $250,000 by Chas. H. Brown, Owen T. Snyder, F. M. Taylor, L. T. Sater, W. J. Sauer and Matthew Posshinger, and will occupy the plant of the new American Elevator Co., recently purchased by Mr. Sauer. The new company will absorb the Snyder-Taylor Elevator Co., of Columbus, and will add a general machine business and a steel casting department.

The Patric Furnace Co., Springfield, O., has purchased the plant of the Evans division of the American Seeding Machine Co., in Springfield, and has moved all its equipment, with the exception of the foundry, which will be conducted in the old plant until the foundry at the Evans plant can be enlarged to meet its requirements, when all machinery will be transferred to its new location, and the old plant sold. The main building of the Evans plant is 40 x 240, three stories, with a three-story wing 50 x 100 feet. The American Seeding Machine Co. has moved the equipment from the Evans division to its Superior division, also in Springfield, and is adding two large buildings to the Superior plant.

The Girard Foundry Co., Girard, O., has begun operating the plant formerly occupied by the Girard Foundry & Machine Co.

The Gallipolis Foundry & Machine Co., Gallipolis, O., has increased its capital stock from $25,000 to $30,000.

The Marion Mfg. Co., of Marion, O., has added $200,000 to its capital stock and will manufacture and sell a new thresher invented and patented by C. J. Gotshall.

At the annual meeting of the Youngstown Foundry & Machine Co., Youngstown, O., Thomas Parrock, general manager, was re-elected chairman of the board of directors. Other directors are as follows: W. J. Wallis, A. E. Adams, E. Hartzell, S. K. Hine, Fanny Montgomery and J. J. Kennedy.

Henry Sievers Sr., has bought the G. Recker machine shops and foundry at Vincennes, Ind., and is making improvements to the plant and reorganizing the management. Gene Recker is manager and the foundry will soon be open for business once more.

The Elkhart Brass Mfg. Co., Elkhart, Ind., has increased its capital stock from $12,500 to $25,000. Albert E. Hausen is president and Wm. H. Anderson, secretary.

The American Register Co., of Goshen, Ind., has been incorporated to manufacture registers and do a general foundry business, and has secured a plant in Goshen which will be at once fitted up for a foundry. The capital stock is $10,000 and the officers are John H. Gotham, president; Otis L. Fuller, vice president, and Geo. A. Riley, secretary and treasurer.

The Chicago Foundry Co. began business July 1 in the foundry formerly operated by the Mudd Mfg. Co., at Fifth, Sixth and Grand avenues, Chicago, and as soon as it gets thoroughly under way expects to melt about 20 tons daily.

Chas. E. Morgan, cashier of the Litchfield Bank & Trust Co., Litchfield, Ill., has purchased the stock of the Litchfield Foundry & Machine Co.

The LaGrange Foundry Co. has been incorporated at Quincy, Ill., by John Willis Gardner, Melvin D. Cheesman and Joseph William Wall. Capital stock, $15,000.

The Hecht Bros. Mfg. Co., Woodstock, Ill., has been incorporated with a capital stock of $25,000, and will operate a brass foundry at Woodstock and later add an iron foundry. Hecht Bros. have been operating a brass foundry at Aurora, Ill., and recently formed the above company and moved their equipment to a new plant at Woodstock.

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Norton Emery Wheel Co., Worcester.

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Gunn, Richards & Co., New York.
Library Bureau, Systematizing Dept., Boston.

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American Air Compressor Works, New York.
Chicago Pneumatic Tool Co., Chicago.
Curtis & Co. Mfg. Co., St. Louis.
Ingersoll-Rand Co., New York.
Norwalk Iron Works Co., So. Norwalk, Conn.

Alloys:
Blackwell Sons & Co., Geo., Ltd., Liverpool, Eng.
New Era Mfg. Co., Kalamazoo, Mich.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.

Analysis—Mechanical:
Keep, W. J., Detroit.

Analysis—Chemical:
Metallurgical Laboratory, Pittsburg.

Anchors:
Lindsay & Co., W. W., Philadelphia.

Babbitt Metal:
Ajax Metal Co., Birmingham, Ala.

Barrels—Steel:
Kilbourne & Jacobs Mfg. Co., Columbus.

Blowers:
American Blower Co., Detroit.
Connersville Blower Co., Connersville, Ind.
Cornell Co., J. B. & J. M., New York.
Monarch Engineering & Mfg. Co., Baltimore.
Paxson Co., J. W., Philadelphia.
Roots Company, P. H. & F. M., Connersville, Ind.
Sturtevant Co., B. F., Boston.

Blowers—Positive Pressure:
Connersville Blower Co., Connersville, Ind.
Piqua Foundry & Mch. Co., Piqua, O.
Roots Company, P. H. & F. M., Connersville, Ind.
Sturtevant Co., B. F., Boston.

Brushes:
Osborn Mfg. Co., Cleveland.

Buildings (Struct. Steel):
Lindsay & Co., W. W., Philadelphia.

Burners (Oil):
Monarch Engineering & Mfg. Co., Baltimore.

Carbonese:
Midvale Mining & Mfg. Co., E. St. Louis, Ill.

Castings (Steel):
Otis Steel Co., Ltd., Cleveland.

Cement (Furnace):
Dixon Crucible Co., Jos., Jersey City.
Gautier & Co., J. H., Jersey City.

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Shelton Metallic Filler Co., Derby, Conn.
Shanafelt Mfg. Co., Canton, O.
Smooth-On Mfg. Co., Jersey City.

Chaplets:
Burdick & Son, Albany.
Fanner Mfg. Co., Cleveland.
Lindsay & Co., W. W., Philadelphia.
Shanafelt Mfg. Co., Canton, O.
U. S. Chaplet Co., New York.

Coke:
Rogers, Brown & Co., Cincinnati.
Surplus Coke Co., New York.

Cores:
Brown Specialty Machry. Co., Chicago.

Core Binders:
Holland Linseed Oil Co., Chicago.
Millers' Products Co., Chicago.
Mills Oil Co., C. E., Syracuse.
National Jeloluse Co., New York.
Robeson Process Co., Camden, N. J.
Sterling Oil Co., Emlenton, Pa.

Core Machines:
Brown Specialty Machry. Co., Chicago.
Falls Rivet & Mch. Co., Cuyahoga Falls, O.
Jones & Atwood, Stourbridge, Eng.
Kent Mfg. Co., Kent, O.
Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Core Tapering Machines:
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Core Ovens:
Atlas Car & Mfg. Co., Cleveland.
Falls Rivet & Mch. Co., Cuyahoga Falls, O.
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Smith Foundry Supply Co., J. D., Cleveland.

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Cost Keeping Systems.
Gunn, Richards & Co., New York.
Library Bureau, Systematizing Dept., Boston.

Cranes:
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Curtis & Co. Mfg. Co., St. Louis, Ill.
Manning, Maxwell & Moore, New York.
Maris Bros., Philadelphia.
Niles-Bement Pond Co., New York.
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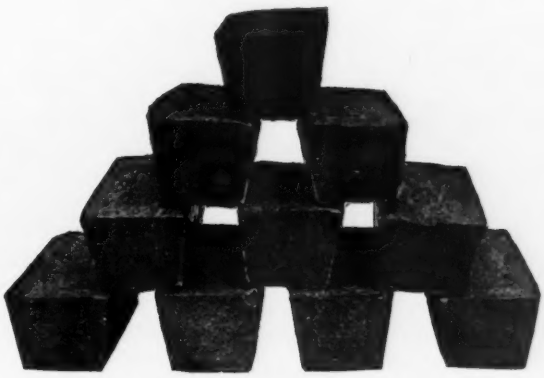

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McCullough-Dalzell Crucible Co., Pittsburg.
Monarch Engineering & Mfg. Co., Baltimore.
Paxson Co., J. W., Philadelphia.
Ross-Tacony Crucible Co., Philadelphia.
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Taylor, Robt. J., Inc., Philadelphia.

Cupolas:
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Gilmour, J., New York.
McCormick Co., J. S., Pittsburg.
Northern Engnrng Works, Detroit.
Paxson Co., J. W., Philadelphia.
Whiting Foundry Equipment Co., Harvey, Ill.

Cupola Linings:
McCormick Co., J. S., Pittsburg.
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United States Steel Piling Co., Chicago.

Elevators:
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Ridgway & Son, Craig, Coatesville, Pa.

Engines (Gas):
Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Engines (Steam):
American Blower Co., Detroit.
Sturtevant Co., B. F., Boston.

Engineers (Foundry, Mech., Elec., &c.):
Dodge & Day, Philadelphia.
Hooper, Geo. K., New York City.
Lindsay & Co., W. W., Philadelphia.

Facings:
Buffalo Foundry Supply Co., Buffalo.
Dixon Crucible Co., Jos., Jersey City.
Hill & Griffith Co., Cincinnati.
R. MacKellar's Sons Co., Peekskill, N. Y.
McCormick Co., J. S., Pittsburg.
Obermayer Co., S., Cincinnati.
Paxson Co., J. W., Philadelphia.
Pettinos Bros., Bethlehem, Pa.
Smith Foundry Supply Co., J. D., Cleveland.
Stephens & Co., Kidwelly, Eng.
Stevens, F. B., Detroit.
Western Foundry Supply Co., E. St. Louis, Ill.

Fans:
American Blower Co., Detroit.

Ferro-Manganese:
Kendall & Flick, Washington, D. C.
Rogers, Brown & Co., Cincinnati.

Ferro-Silicon:
Roessler & Hasslacher Chemical Co., New York.
Rogers, Brown & Co., Cincinnati.

Fillers (Metallic):
Clark Cast Steel Cement Co., Shelton, Conn.
Shanafelt Mfg. Co., Canton, O.
Shelton Metallic Filler Co., Derby, Conn.
Smooth-On Mfg. Co., Jersey City.

Fillets:
Cleveland Fillet Co., Cleveland, O.
Shanafelt Mfg. Co., Canton, O.

Fire Brick:
Gautier & Co., J. H., Jersey City.
Maurer & Son, Henry, New York.
Paxson Co., J. W., Philadelphia.

Fire Sand:
Carborundum Co., Niagara Falls, N. Y.

Flasks:
Adams Co., Dubuque, Ia.
Barnett Fdy. Co., Oscar, Newark.
Brass Founders' Supply Co., Newark.

Flasks (Snap):
Adams Co., Dubuque, Ia.
Diamond Clamp & Flask Co., Richmond, Ind.
Obermayer Co., S., Cincinnati.
Paxson Co., J. W., Philadelphia.
Smith & Caffrey Co., Syracuse, N. Y.

Foundry Equipment (Iron & Brass):
Barnett Fdy. Co., Oscar, Newark.
Etting, Edward J., Philadelphia.
Obermayer Co., S., Cincinnati.
Pangborn Co., Thos. W., New York.
Sly, W. W. Mfg. Co., Cleveland.
Stevens, F. B., Detroit.
Taylor, Robert J., Inc., Philadelphia.
Weiner Co., Ernest, New York.

Foundry Supplies:
Fair, Taylor & Co., San Francisco.
Hill & Griffith Co., Cincinnati.
McCormick Co., J. S., Pittsburg.
Obermayer Co., S., Cincinnati.
Osborn Mfg. Co., Cleveland.
Pangborn Co., Thos. W., New York.
Paxson Co., J. W., Philadelphia.
Shanafelt Mfg. Co., Canton, O.
Smith Foundry Supply Co., J. D., Cleveland.
Stevens, F. B., Detroit.
Taylor, Robert J., Inc., Philadelphia.

Furnaces (Melting):
Barnett Foundry Co., Oscar, Newark, N. J.
Monarch Engineering & Mfg. Co., Baltimore.
Paxson Co., J. W., Philadelphia.
Rockwell Engineering Co., New York.

Grinding Machinery:
Adams Co., Dubuque, Ia.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Norton Co., Worcester.
Ransom Mfg. Co., Oshkosh, Wis.

Grinding Wheels:
Norton Co., Worcester.
Pike Mfg. Co., Pike, N. H.
Vitrified Wheel Co., Westfield, Mass.

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The Cost of It

The expense of a modern system of cost-keeping need be no greater than a crude, antiquated and inefficient way of keeping accounts.

Such a system is accurate, quick and in ample detail, and it gives the detailed costs of every part of the work while the business is fresh—when it is most valuable as a basis of comparison.

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GUNN, RICHARDS & COMPANY

Production Engineers and Public Accountants.....

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224 ST. JAMES STREET, MONTREAL

Grinding Pans:
Crossley Mfg. Co., Trenton, N. J

Hammers (Pneumatic Chipping):
Dayton Pneumatic Tool Co., Dayton, O.
Ingersoll-Rand Co., New York.

Heating & Ventilating Apparatus:
American Blower Co., Detroit.
Sturtevant Co., B. F., Boston.

Hoists:
Curtis & Co., Mfg. Co., St. Louis.
General Pneumatic Tool Co., Montour Falls. N. Y.
Harrington Son & Co., Edwin, Philadelphia.
Niles-Bement-Pond Co., New York.
Northern Engrg. Works, Detroit.
Pawling & Harnischfeger, Milwaukee.
Sellers & Co., Inc., William, Philadelphia.
Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York.

Hoists (Pneumatic):
Ridgway & Son, Craig, Coatesville, Pa.

Hydrofluoric Acid:
General Chemical Co., Philadelphia.

Industrial Ry. Equipment:
Atlas Car & Mfg. Co., Cleveland.
The Gregg Company, Ltd., Newburg, N. Y.
Wiener & Co., Ernst, New York.

Iron Ore:
Rogers, Brown & Co., Cincinnati.

Lacquers:
New Era Lustre Co., New Haven.

Ladles:
Northern Engrg. Works, Detroit.

Molding Machines:
Adams Co., Dubuque, Ia.
Arcade Manufacturing Co., Freeport, Ill.
Berkshire Mfg. Co., Cleveland.
Herman Pneumatic Machine Co., Zelienople, Pa.
McPhail Molding Machine Co., Davenport, Ia.
Manning, Maxwell & Moore, New York.
Maywood Foundry & Machine Co., New York.
Mumford Co., E. H., Philadelphia.
Paxson Co., J. W., Philadelphia.
Pridmore, Henry E., Chicago.
Tabor Mfg. Co., Philadelphia.
Turner Machine Co., Philadelphia.

Oil (Linseed):
Holland Linseed Oil Co., Chicago.

Pattern Letters:
Shanafelt Mfg. Co., Canton, O.

Packing (Rubber Sheet):
Smooth-On Mfg. Co., Jersey City.

Parting Materials:
Foundy Specialty Co., Cincinnati.
Imperial Fluxing Co., Marion, Ky.
Partamol Co., New York.

Patterns (Metal & Wood):
Herman Pneumatic Machine Co., Zelienople, Pa.

Pattern Shop Equipment:
Fox Machine Co., Grand Rapids, Mich.

Phosphorizers:
McCullough-Dalzell Crucible Co., Pittsburg.

Phosphor Tin:
Crescent Phosphorized Metal Co., Philadelphia.
Lang, R. F., New York.
New Era Mfg. Co., Kalamazoo.

Pig Iron:
Addy & Co., Mathew, Cincinnati.
Baird & West, Detroit.
Bartlett & Co., N. S., Boston.
Cherry Valley Iron Co., Pittsburg.
Columbus Iron & Steel Co., Columbus.
Dalton, Nash & Co., New York.
De Camp Bros. & Yule, St. Louis.
Dimmick & Co., J. K., Buffalo.
Domhoff & Joyce Co., Cincinnati.
Elliott, Debevoise & Anderson, New York.
Field Sales Agency, Robert, Cincinnati.
Goodrich & Co., F. A., Detroit.
Hillman & Son, J. H., Pittsburg.
McKeefrey & Co., Leetonia, O.
Mohr, J. J., Philadelphia.
Pickands, Brown & Co., Chicago.
Pickands, Mather & Co., Cleveland.
Pilling & Crane, Philadelphia.
Rogers, Brown & Co., Cincinnati.
Shepard, Chas. G., Buffalo.
Stevens, F. B., Detroit.
Thomas Furnace Co., Milwaukee.
Walter-Wallingford & Co., Cincinnati & Pittsburg.

Plumbago:
Dixon Crucible Co., Jos., Jersey City.
Gautier & Co., J. H., Jersey City.
Hill & Griffith Co., Cincinnati.
McCullough-Dalzell Crucible Co., Pittsburg.
Obermayer Co., S., Cincinnati.
Pettinos Bros., Bethlehem, Pa.
Ross-Tacony Crucible Co., Philadelphia.
Stevens, F. B., Detroit.

Polishers' & Platers' Supplies:
Stevens, F. B., Detroit.

Riddles:
Adams Co., Dubuque, Ia.
U. S. Chaplet Co., New York.

Sand:
Albany and North River Molding Sand Co., Albany, N. Y.
Buffalo Fdy. Supply Co., Buffalo.
Dresden Sand Co., Dresden, O.
Paxson Co., J. W., Philadelphia.
Pangborn Co., Thos. W., New York.
Standard Sand & Machine Co., Cleveland.
Stevens, F. B., Detroit.

Sand Blast Machinery:
Drucklieb, C., New York.
Pangborn Co., Thos. W., New York.
Paxson Co., J. W., Philadelphia.
Tilghman-Brooksbank Sand Blast Co., Philadelphia.

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